LMI Technologies GmbH

User Manual

Optical 3D Skin Measuring Device

PRIMOS*lite*

With Software PRIMOS 5.7

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PRIMOS 5.7 IS IN ENGLISH, FRENCH, GERMAN, PORTUGUESE AND SPANISH RELEASED. THE LANGUGE SELECTION IS AVAILABLE ON SYSTEM SETTING PANNEL.

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1. Quickstart

The Software ***PRIMOS*** is subdivided in two parts. It contains one part which is exclusively dedicated to the uptake of measurement data and another part which concerns itself with the evaluation of the gained data. This brief guide serves the purpose of fast and easy measurement data uptake and the evaluation of this data. All further functions are explained in detail in the User Guide.

1.1 Uptake of Measurement Data

1.1.1. Starting PRIMOS – Software

After starting the PRIMOS software by double clicking on the program symbol on the desktop, the opening window appears. (img.1)

Img. 1.1 Starting window

Explanation of all present symbols in the opening window:

Menu	Button - Label	Icon	Function
Applications	Open document		Opens a dialogue window in which saved data can be called upon.
	3D Matching for elastic surface structures		Opens the dialogue window “Matching”
	Open database		Opens integrated database
	Open Printer Output file		Opens the Printer file for the presentation and output of measurement data
	Start Measurement program		Opens the measurement program
	Start calibration		Opens the calibration program

1.1.2. Open Measuring program

In the opening window you can find the symbol for starting the measuring window. The measuring mode is opened by clicking on the program symbol (img.1).

- Open the menu item **Applications| Start measuring program** or push the **button** .

If the test person database is activated a window appears where you will be asked if you want to use it. More information about the test person database can be found in chapter 15.

1.1.3. Establish Pre-adjustments

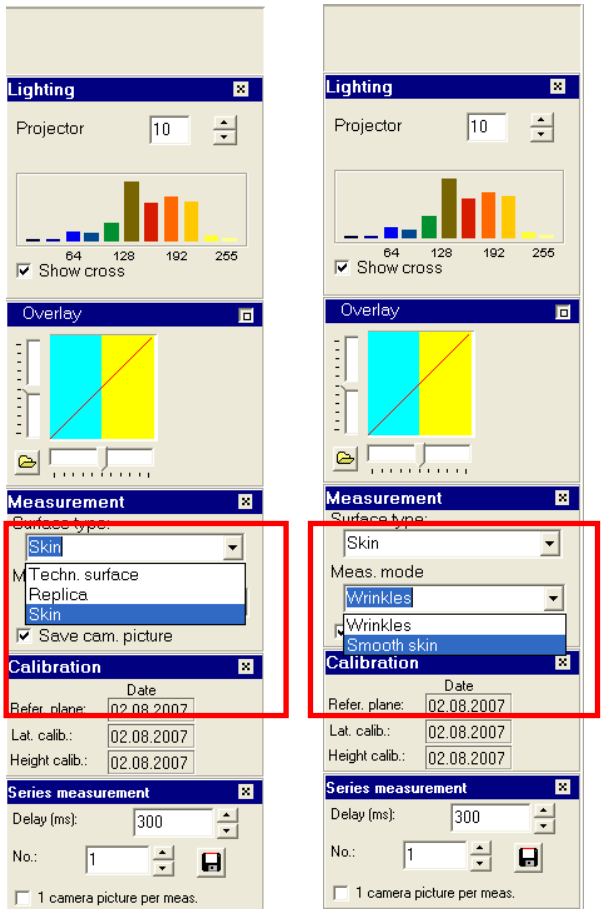
The menu bar at the right edge of the picture controls various measurement parameters. The most important settings for the measurement are those concerned with the settings of the measurement object. The Standard options in the menu item **Measurement | Type of measurement** are:

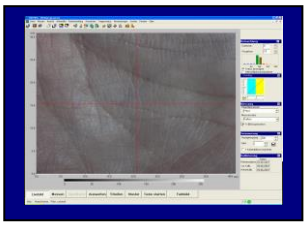
- Techn. Surface
- Replica
- And skin.

Thus, for live measurements on the test person, the skin mode should be selected. Subsequently, the measuring mode for the skin measurement must be designated. Furthermore, the lighting can be adjusted to suit the current lighting conditions and the brightness distribution graphically displayed.

1. Step: Selecting the type of surface

2. Step: Selecting the measuring mode





In the **Drop Down Menu**, the measuring procedure can be chosen. By default, **“Wrinkles”** and **“Smooth skin”** are available.

For measurements on smooth skin e.g. for studies of the under arm, the **Mode “smooth skin“** should be selected, for measurements of wounds, scars, wrinkles etc., the **mode “Wrinkles”** should be selected

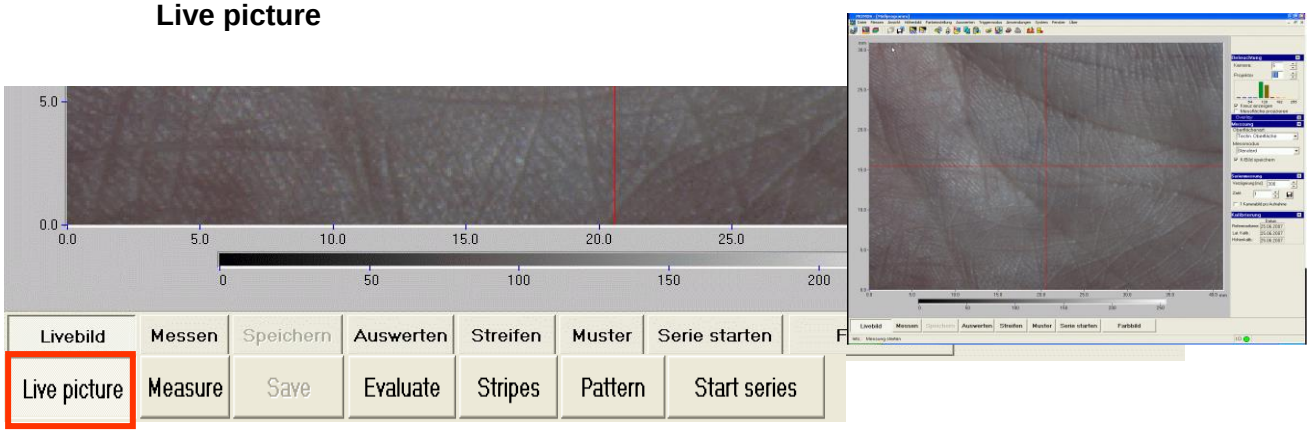
For Measurements with **PRIMOS*lite*** it is always recommended to use the **Wrinkles** Mode because this mode is very insensitive against shaking.

Img. 1.2 Appoint Surface type and measuring mode

1.1.4. Live image / Start Measurement

In the bottom menu bar, several program symbols can be found. By clicking on the button “Live Image” (img. 1.2) the camera is activated and shown on the monitor.

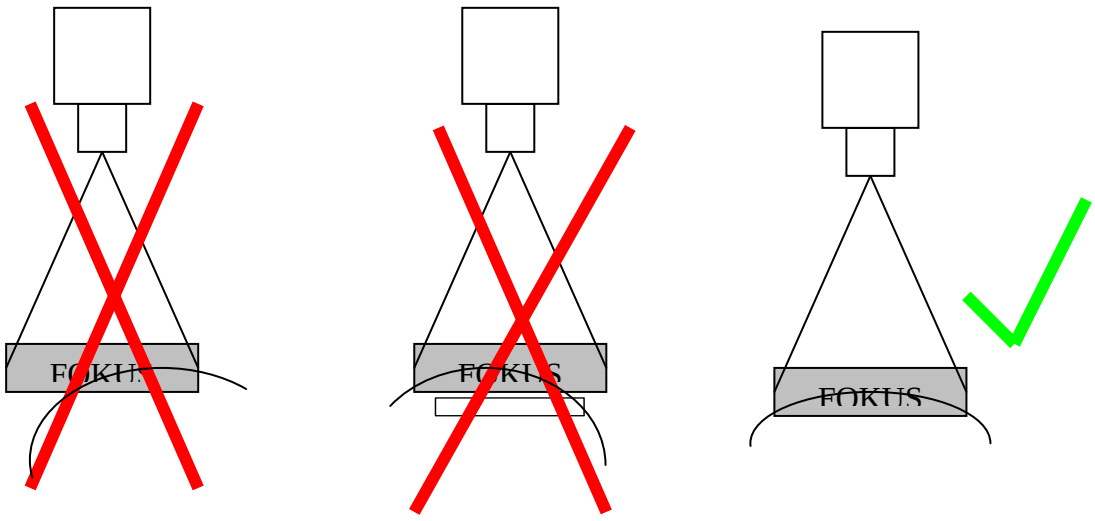
- Open the Menu item **Measure | Start / Stop Live picture** or click on the button **Live picture**



Img. 1.3 Button in the measuring menu

1.1.5. Focussing of the Object to be measured

After selecting the measuring mode, the object to be measured must be focused. It is important to make sure that not only the center of the object to be measured is in the focus. The edges should be in the in focus area, too. At the PRIMOS*lite*, the best possible focus area is on the end of the spacer.



Img. 1.4 determine surface type and measuring mode

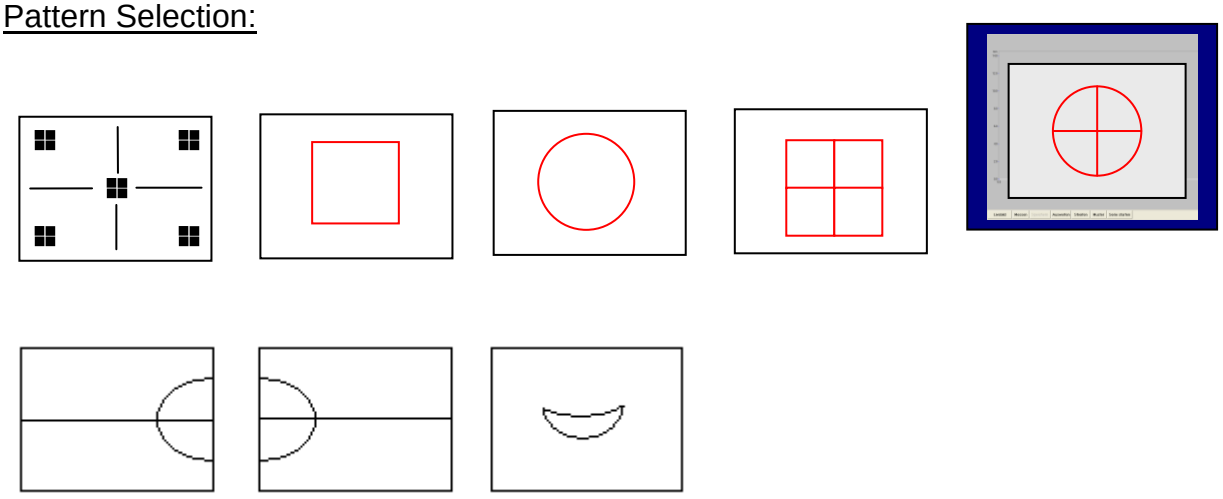
Focussing with Pattern

Through multiple clicks of the button “Pattern“, various patterns can be adjusted. The pattern “Crosshair“ is suggested which is a helpful function for the focusing of the object to be measured.

- Open the menu item **View | Pattern** or press the button **Pattern**.

Img. 1.5 Button in the measuring menu

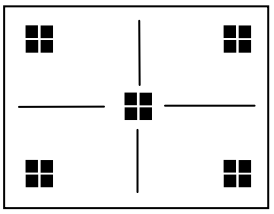
Pattern Selection:



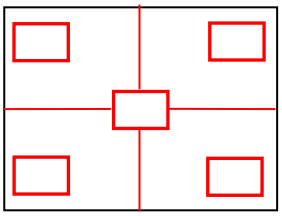
The last three patterns are adapted for the measurement of eye wrinkles and eye bags. The pattern will be saved on the *.kam image so that it is much easier to locate the same skin area by using the overlay function for measuring several times. More detailed information therefore you can find in chapter 6 “measuring” and chapter 7 “overlay”.

Focussing the item to be measured e.g. skin with the crosshair:

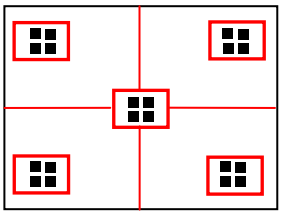
If the button **Pattern | Cross** is activated, then a projected crosshair on the measuring object and a blended in crosshair on the screen become visible. See img. 1.6. It is then the aim to get the projected and the blended in crosshairs to coincide with one another.



Img. 1.6 Projected Crosshair

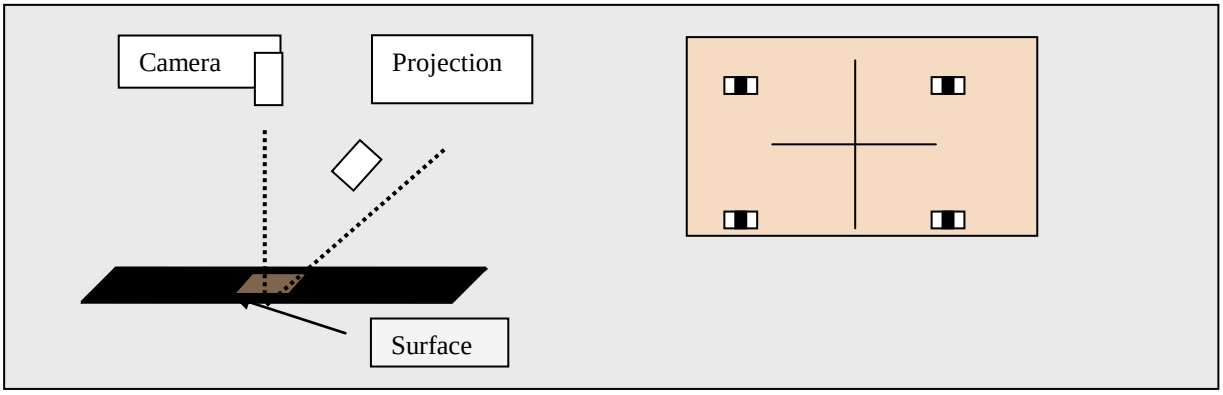


Img. 1.7 Blended in crosshair



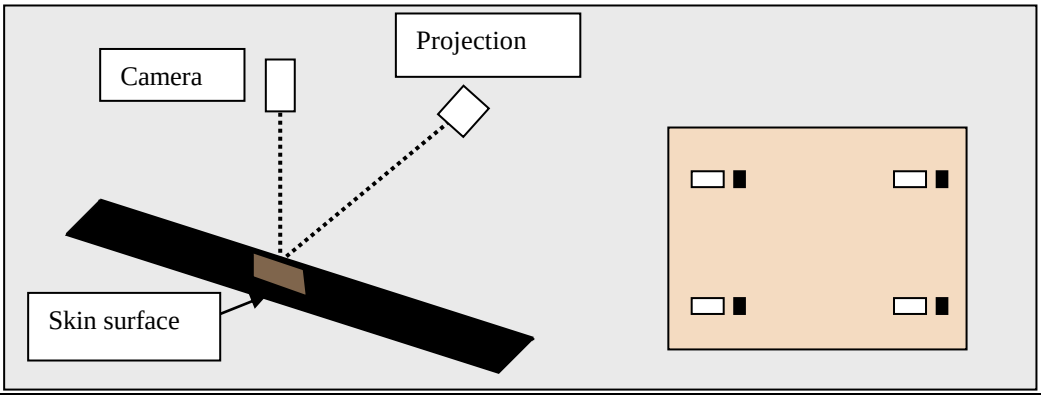
Img. 1.8 Projected and blended in crosshair

The sensor is in optimal focus when the projected cross coincides with the blended in cross. However, this only applies if the measuring surface is parallel to the recording field. See img. 1.9. at this it is usually concerning the position of a body part e.g. position of the forearm.



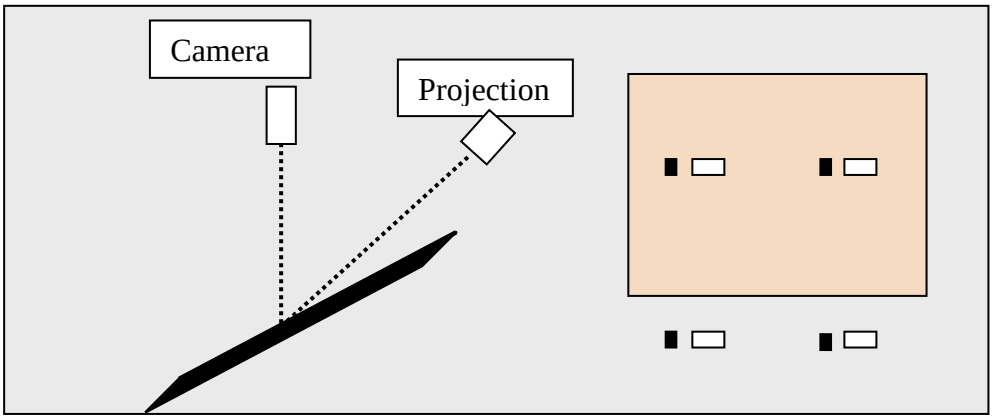
Img. 1.9 Even and parallel measuring object to measuring camera

When the skin surface exhibits a tilt, that is, the skin surface is not parallel to the camera, then the distance between the camera and the measuring surface changes. This leads to the cross at the edge of the image not being in line with the blended in crosshair and cannot be positioned accurately.



Img. 1.10 Level but tilted measuring surface to camera

The same thing occurs when the tilt of the surface lies to the other side of the focus line of the camera.



Img. 1.11 Level but tilted measuring surface to measuring camera

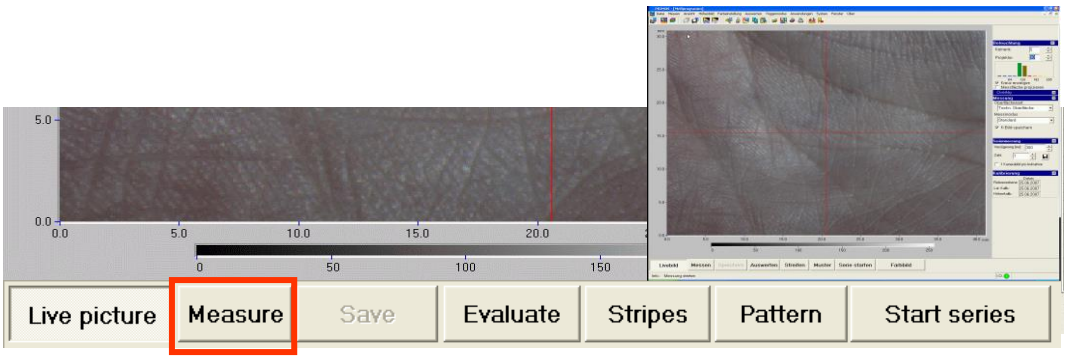
1.1.6. Recording of the Measured Data

After all adjustments have been made correctly, the measurement can be started with a single click of the activator on the sensor (s. the picture below) or on the **Button "Measure"** in the measuring window.

Click ones the activator to see the **Live Picture** with the second click you **start the measurement**.

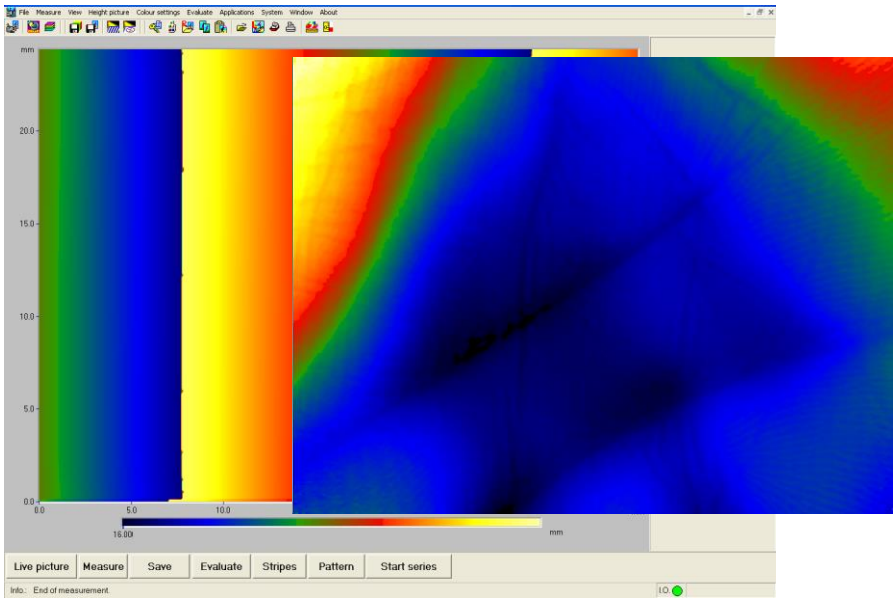
Or you could measure in the software:

- Click the button **live picture**
- Open the measuring window **Measure | Start measurement**
  Or the button **Measure**



Img. 1.12 Menu bar in the bottom window area

Initially, the measurement results are displayed graphically in a colour coded height image, see Img. 1.13. The measurement results contain all the 3D information of the measured object which means, that the macro structure (form, waviness) as well as micro profile (Skin structure, wrinkles) are available. The scales is given under the colour coded height image where black represents the deepest point in the image and the colours change to yellow depending on their height.



Img. 1.13 Colour coded 3D height image

Should the measurement have not been successful, the measured image can be discarded without saving through a click of the button “Live Picture“ and the measurement can be repeated.

A good measuring result should be saved directly. To do this, the button “save” at the bottom of the screen can be used or another option is the menu item “file” and then “save picture” in the top menu bar.

- Open the menu window **File | save Height Picture, camera Picture, Colour camera picture** or the button **Save.**

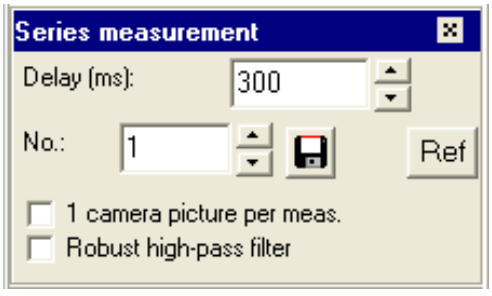
Img. 1.14 Button in Menu bar

1.1.7. Series Measurement

To attain a higher statistical security, it is recommended to take several pictures of the same treatment condition. For this, the function series measurement is intended. Before it can be used the storage space must be selected.

Please verify that the measurement modes “skin“ and “wrinkles“ are correctly adjusted. After that you can find the display for the settings of the series measurement at the right side of the screen. You can activate this window by a single and/or double click on the symbol next to the denotation Series measurement. The **Delay** between the individual measurements, the number if images and the place in which the images shall be automatically saved can be chosen.

Through clicking on the disk symbol, a window opens for the submission of the file name.



Img. 1.15 Settings for the series measurement

By checking the box in the bottom of the window **“1 Camera picture per meas.“** each image is saved in the format of *omc* and *kam*. If the box is not checked there is only saved a camera image (*cam* file) and the corresponding height image (*omc* file) of the first image of the series

measurement. For all further measurements, only the height images are saved and not the corresponding camera image. An automatic high-pass filter can also be chosen.
Then the serial measurements can be in progress.

- Open the menu window **Measure | Start Series Measurement** or use the button start series measurement

Img. 1.16 Series measurement mode

1.1.8. Allocation of File Names

It is recommended that the patient and/or test person is given a name, relating to the treatment as well as characterising the treatment stage. The software automatically adds numbering.

e.g. choose the name:

CB_SCAR_RH_T0

(CB = Name of person, Scar = object to be measured, RH = Place of measurement e.g. right hand, T0 = time of measurement.)

For a series of 3 measurements the result is:

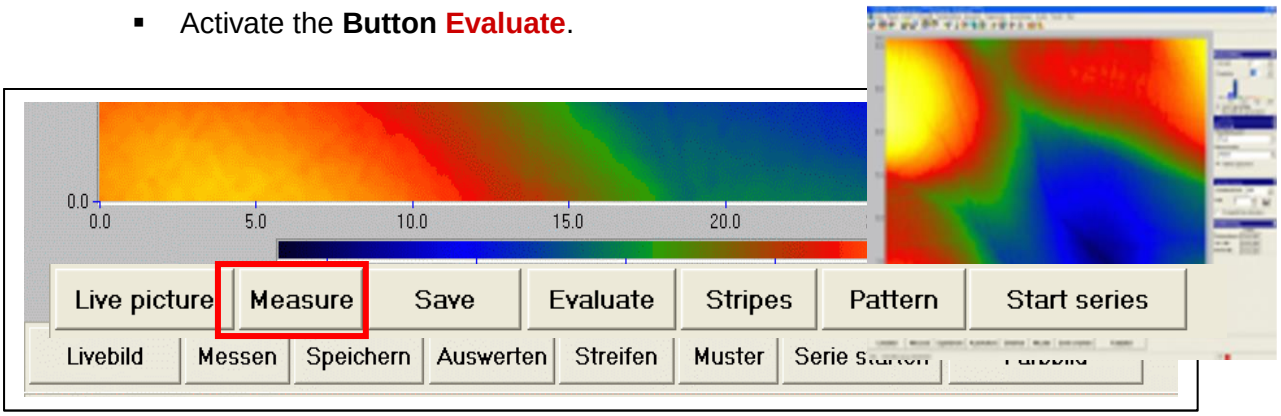
CB_SCAR_RH_T0_01
CB_SCAR_RH_T0_02
CB_SCAR_RH_T0_03

The data is automatically saved and after the measurement, the database opens in which all files are shown.

1.2. Evaluation of measurement data

For the evaluation of the recording, the height image should firstly be saved. The saving however can be conducted subsequently in the evaluation window through the activation of the **Evaluate** button.

- Activate the **Button Evaluate**.

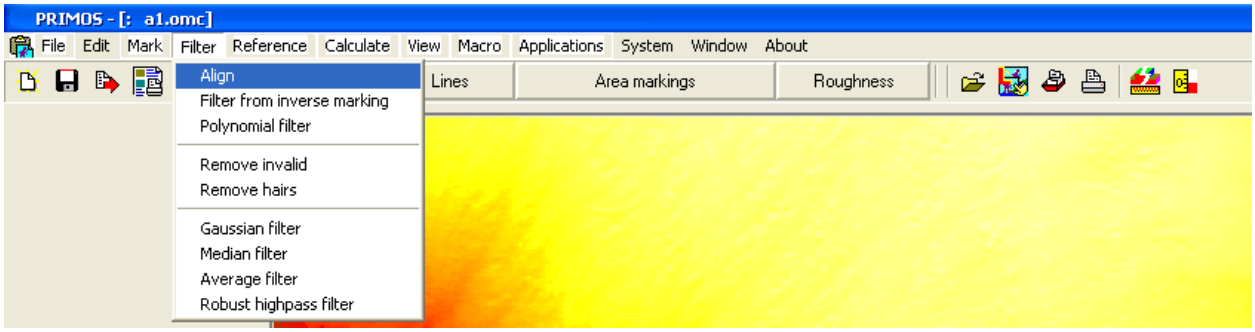


Img. 1.17 Transfer height image into the evaluation surface

1.2.1. Filter options

For the further processing, various filters are available. At the beginning of the processing it is re - commended to align the images. The image is automatically aligned under the menu item **Filter| Align**.

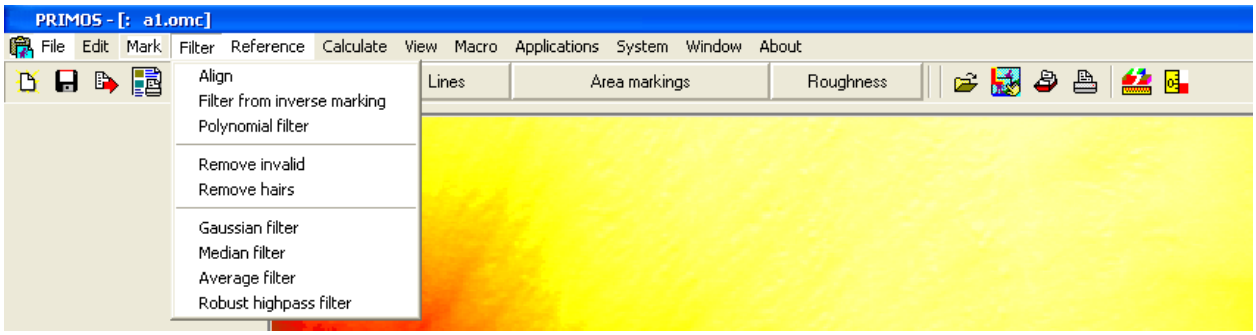
- Open the menu window **Filter | Align**



Img. 1.18 Height image in evaluation mode with function

As previously mentioned, the topographic height image includes information about the form as well as the micro structure. In most cases however, only the micro structure is of interest. To separate these two structures, two filters are available. The polynomial filter and the robust highpass filter.

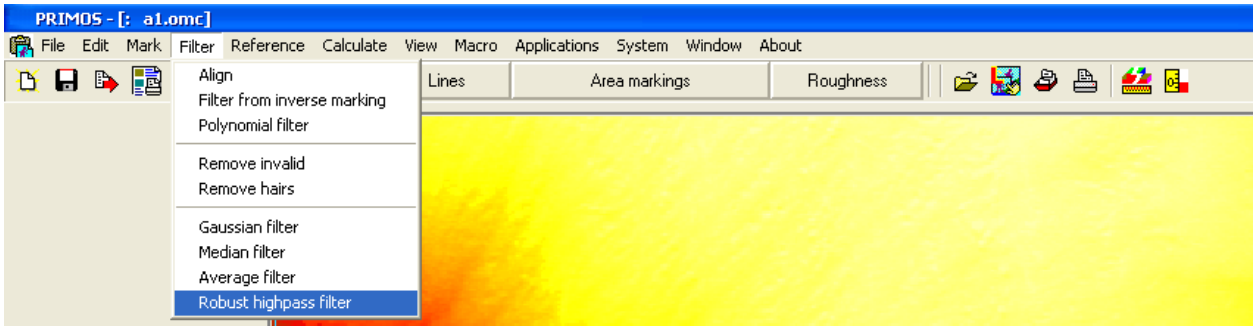
- Open the menu window **Filter | Robust highpass filter or**
  | Polynomial filter



Img. 1.19 Filter function

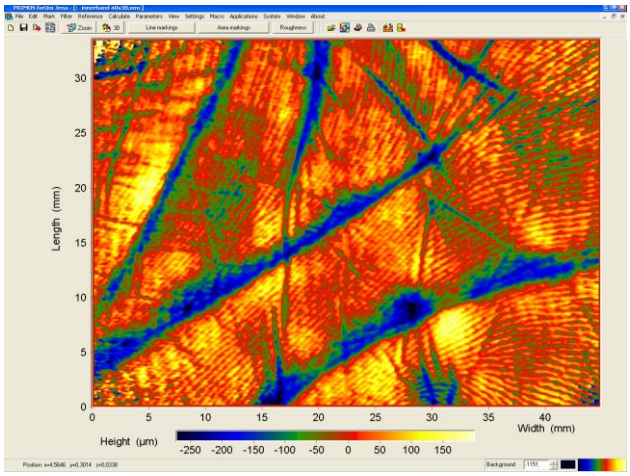
The robust highpass filter delivers a fast separation of the micro structure (high frequency) and the form (deep frequency). This filter is pre assigned and does not allow the user any setting options regarding the separation.

- Open the menu window **Filter | Robust highpass filter**



Img 1.20 Filter functions – Robust high pass filter

After the image has been aligned and freed of the form, the wrinkle structures are clearly recognisable in the image and the wrinkles can then be measured.

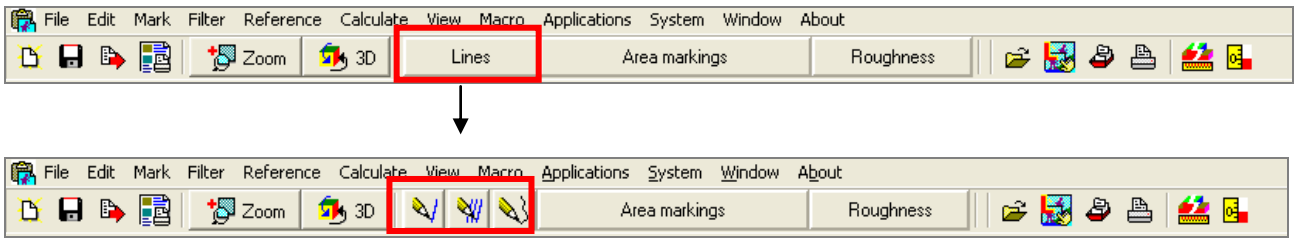


Img. 1.21 Aligned and filtered height image with clearly recognisable wrinkle structure

1.2.2. Inserting Intersecting line/-s

For the calculation of the line roughness, one or more intersecting lines can be placed into the height image.

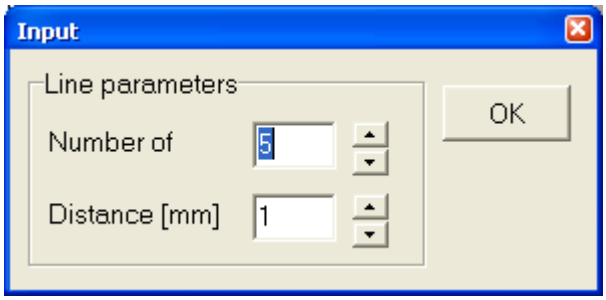
Open the menu window **Marking | Line marking** or the Button **Line marking activated.**



Img. 1.22 Draw lines

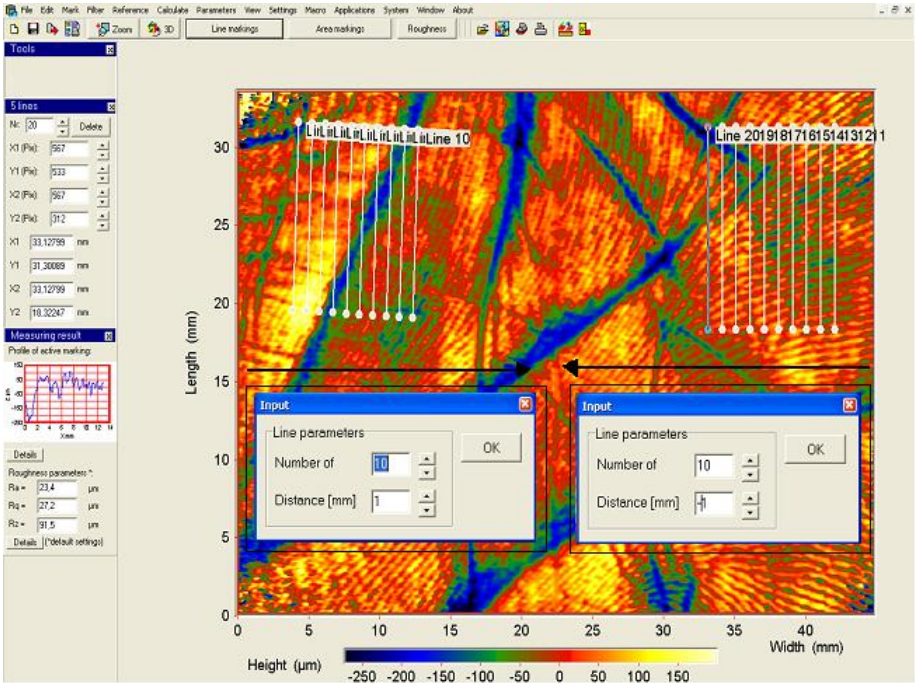
For the simple determination of the wrinkle deepness, an intersection line can be initially put anywhere into the image. For this, the button **line marking** in the top menu bar should be activated. Activate the button **"Draw line"** and use the curser to draw the line. With help of the mouse curser, an exact length and position can be defined for each line.

For the insertion of a desired number of lines, use the button **Draw parallel lines.** After drawing a line a window appears where the number of lines and the distance between the lines can be set. These settings will be stored.



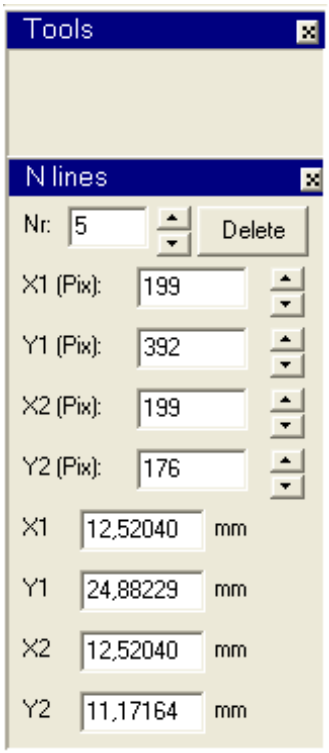
Img. 1.23 Submission window for user defined amount of lines

If a negative value is given for the intervals, the lines are arranged parallel to one another and going left.



Img. 1.24 Setting direction of lines

If lines are set outside of the calculation window, then an error message appears “**Out of Area**“.

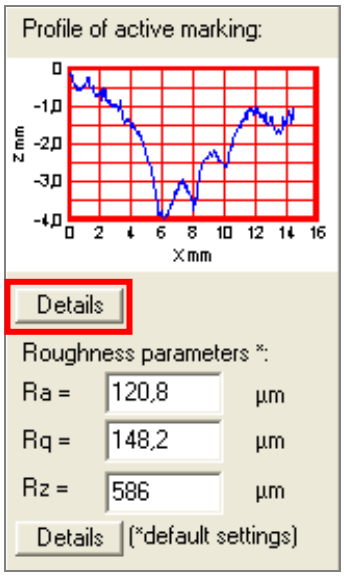


In the left side of the image, the coordinates of the individual lines are shown. If several lines are drawn in the image, the line number can be selected and can be individually deleted on demand.

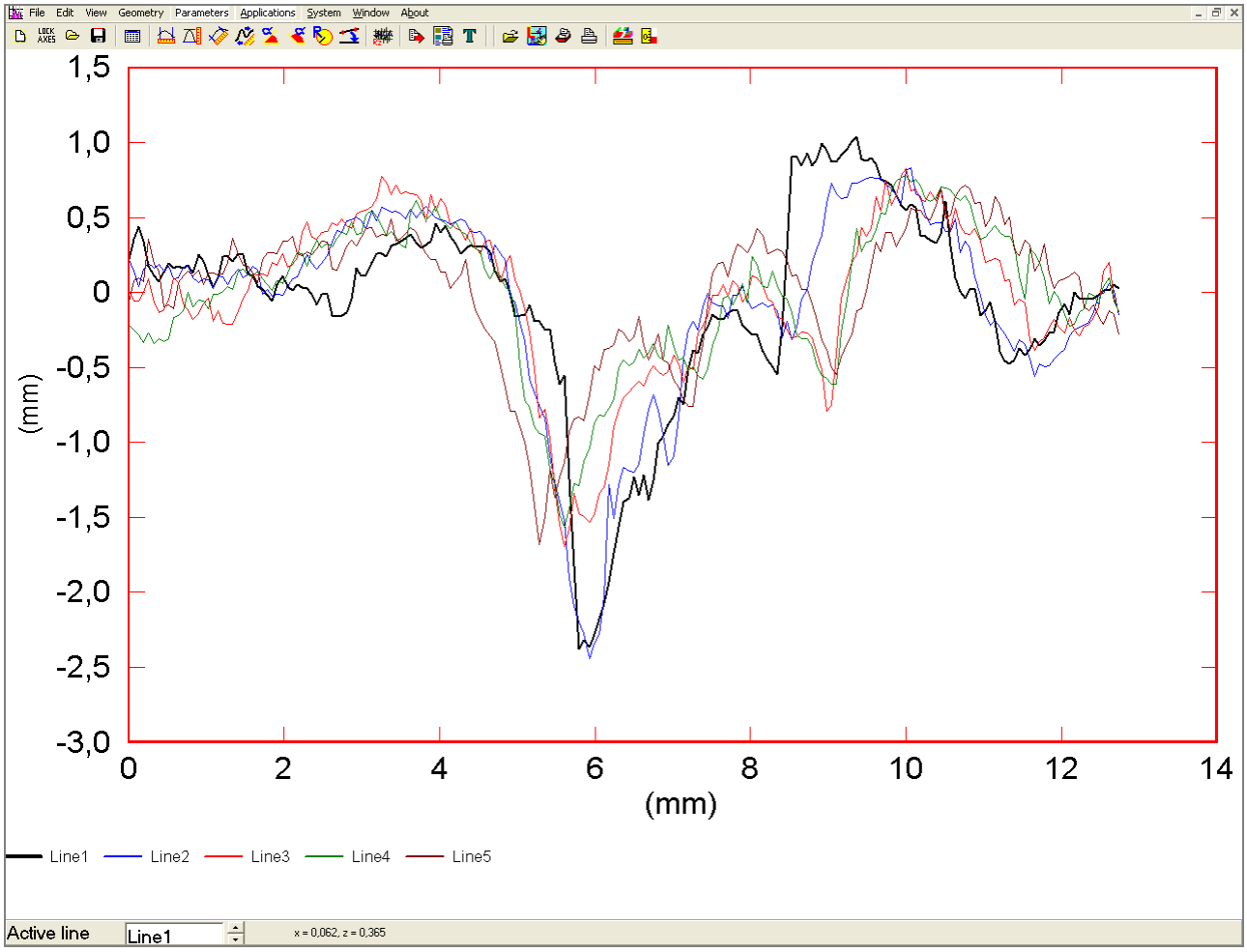
Img. 1.25 line drawing window

1.2.3. Show topography of the intersecting line/-s.

To view the profiles for further calculations there is a possibility to activate the button "details" under the miniature view on the left side.



Img. 1.26 Program symbol diagram



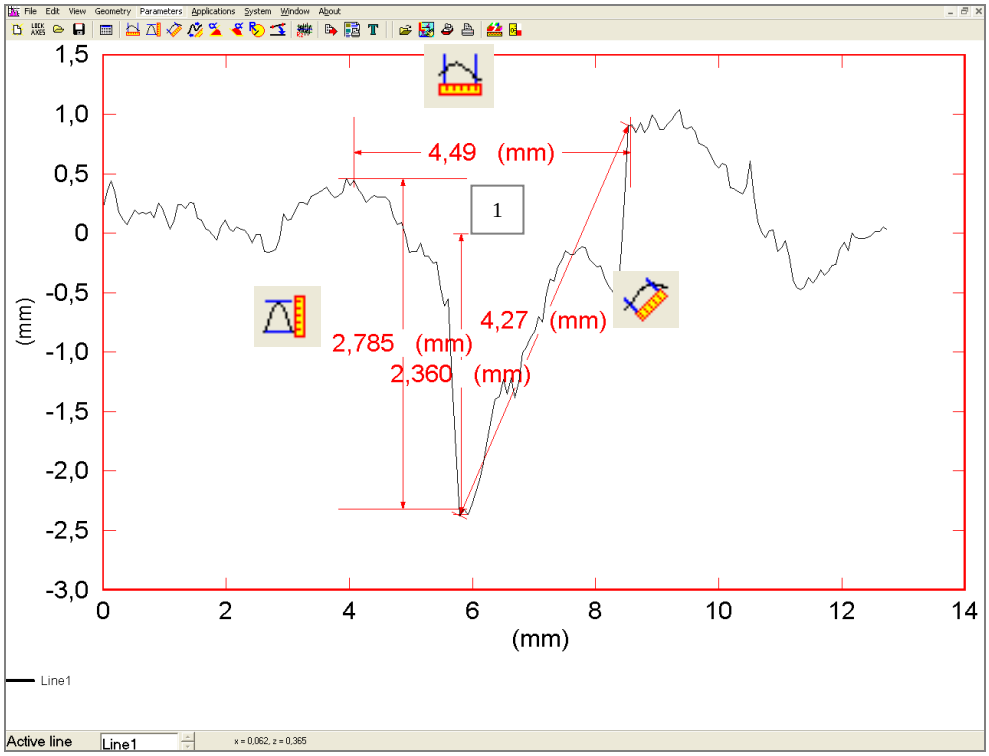
Img 1.27 2D Profile along the intersection line

1.2.4. Calculation and value display of intersecting lines

By clicking on the intersection line, measuring points can be set. If, for instance, you wish to mea - sure the depth of a wrinkle, one point must be set at the lowest point of the wrinkle and another at the reference. For the evaluation, following tools are available:

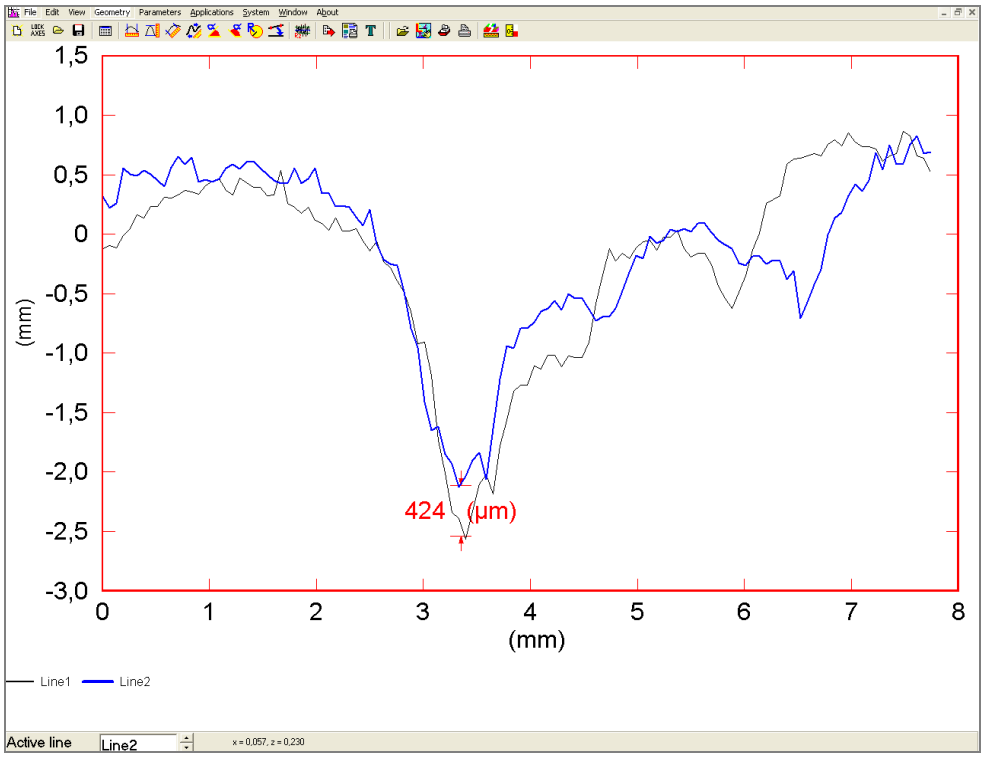
- Depth ,
- The width ,
- The Radius ,
- Curve length
- And the angle

The measuring points are set by a single click of the left mouse button. If only one point is set, the program calculates the depth to the zero level. See below. Img. 28 with the value of 1.



Img. 1.28 Parameter for the line measurement

If there are several lines and you want to measure between them or to measure on an inactive line you have to select the inactive line on the lower edge of the screen. Activated lines are drawn thicker. (see chapter 13. intersection lines)



Img. 1.29 Parameter for the line measurement

1.2.5. Matching

To follow the course of a treatment and assess the difference between before and after, the evaluation software includes the possibility of the so-called matching of data. This means, two images or more recorded at different points in time can be compared against each other. Presupposition for this is a precise and reproducible recording of the data. For this, the overlay function (view handbook) is recommended. With this function the original camera image can be displayed in the live picture as a half transparent image. This way it is easier to find the previously recorded structure again.

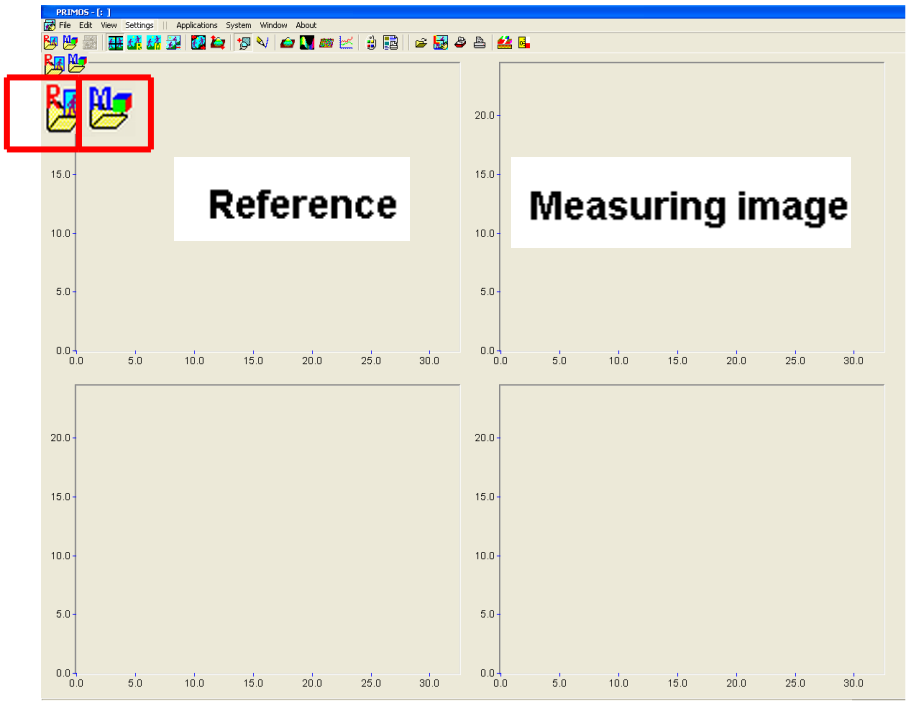
Img. 1.30 start 3D-Matching

For the matching, image data can be compared before, during and after the treatment. For the area retrieval it is important that at least 60% of the image surface conforms with the original reference data set (before the treatment).
The images that should be compared must already be saved. In the starting window after opening the program, the

button for the matching function can be found.
It opens through a single click.

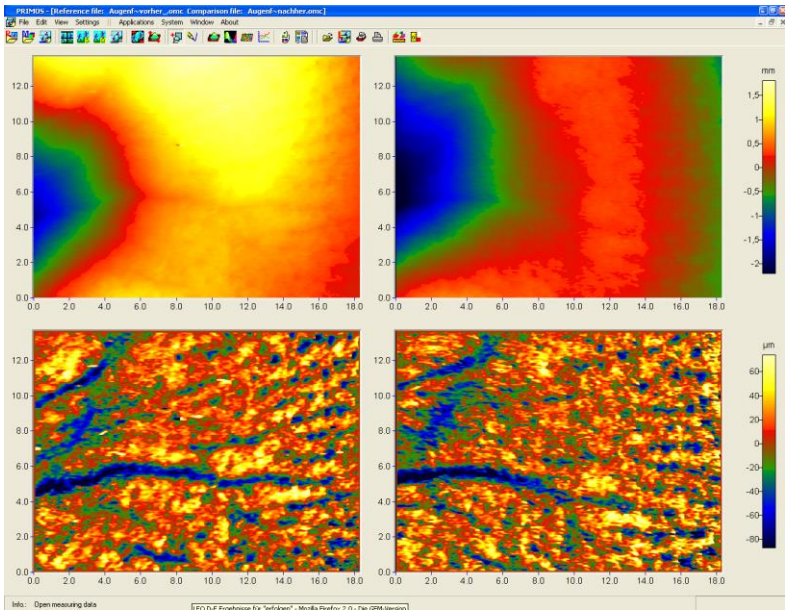
- Activate the button **3D-Matching for elastic surface**

Implementing the picture files

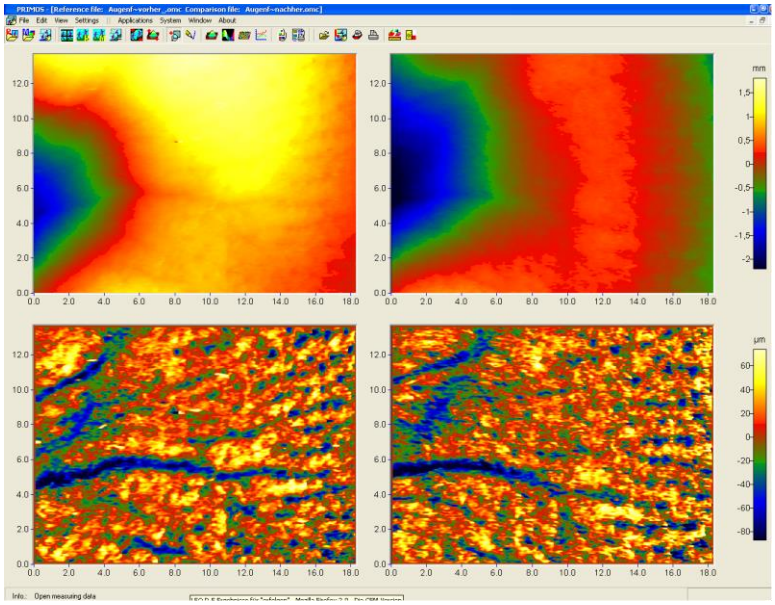


Img. 1.31 Starting window 3D Matching

In the first step, the reference image is opened and inserted. The reference image appears in both the left fields. In the top field it appears in its original condition and in the bottom field already filtered. Here the filter functions are also not modifiable by the user. Afterwards the measuring file can be opened and appears in the two right windows.



Img. 1.32 Reference and measured file opened

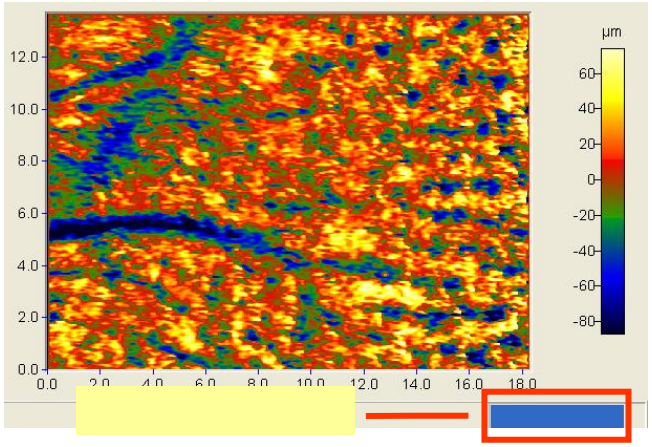


Img 1.33 Start Matching

By clicking on the program symbol „Start Matching”, the matching sequence is started. The measured file is fitted to the reference file through the so-called elastic matching, without altering the for the evaluation necessary micro structures.

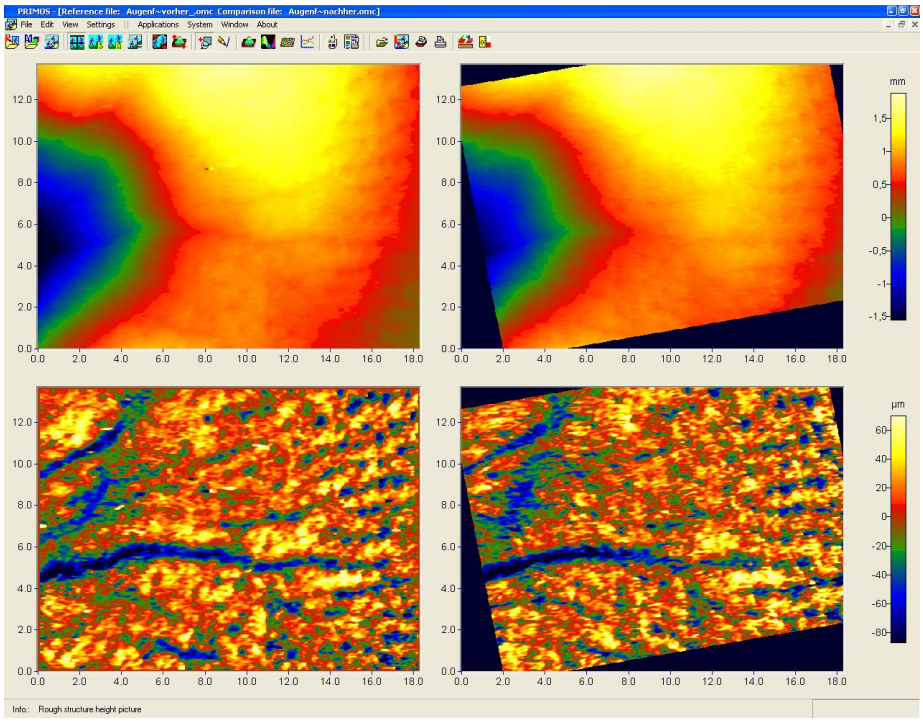
Display of the Matching Duration

The matching can take, depending on the quality of the 3D data and the conformity of the recorded data more or less time. The progress of the matching is displayed in the bottom right corner of the screen through a progressing bar.



Img. 1.34 Progress control

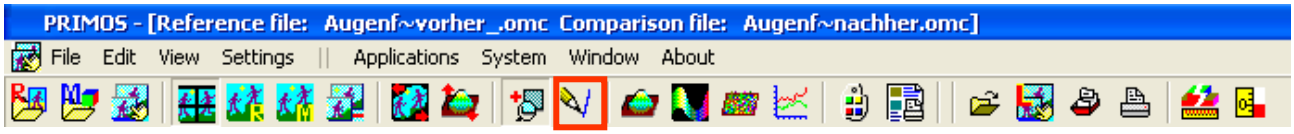
After the matching is complete, the displacement is shown through the black edges.



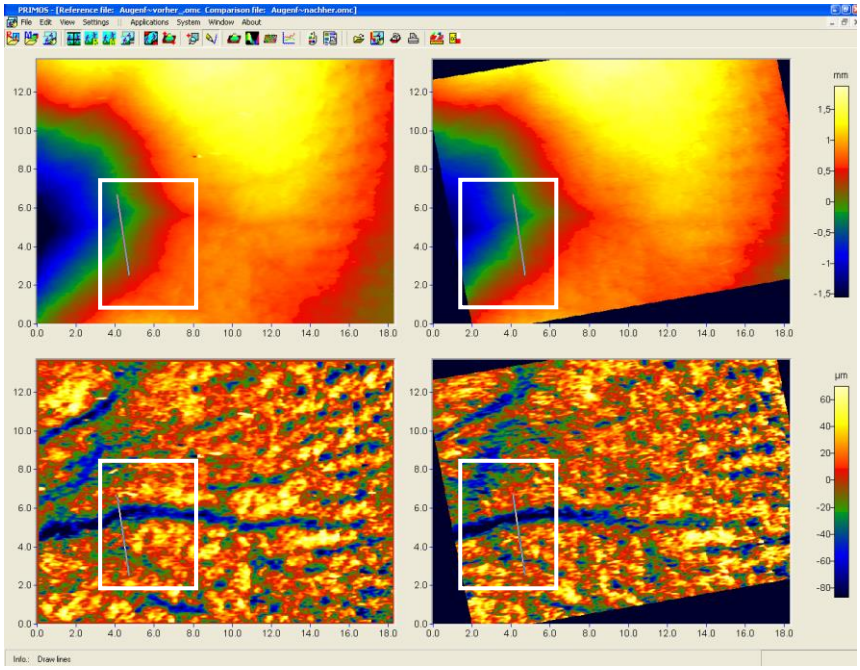
Img. 1.35 Finished matching procedure

Inserting Intersection line

Through clicking on the program symbol intersection line (Img. 35), an intersecting line can be placed into the image file. It makes no difference in which of the 4 images the line is placed. The intersecting line is automatically fitted into all 4 images (Img. 36).


PRIMOS - [Reference file: Augenf~vorher_.omc Comparison file: Augenf~nachher.omc]
File Edit View Settings Applications System Window About

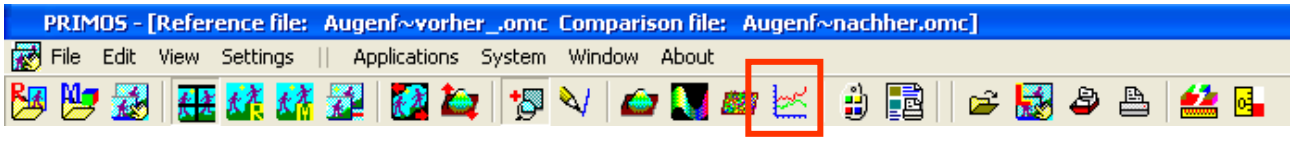
Img. 1.36 Intersecting line tool



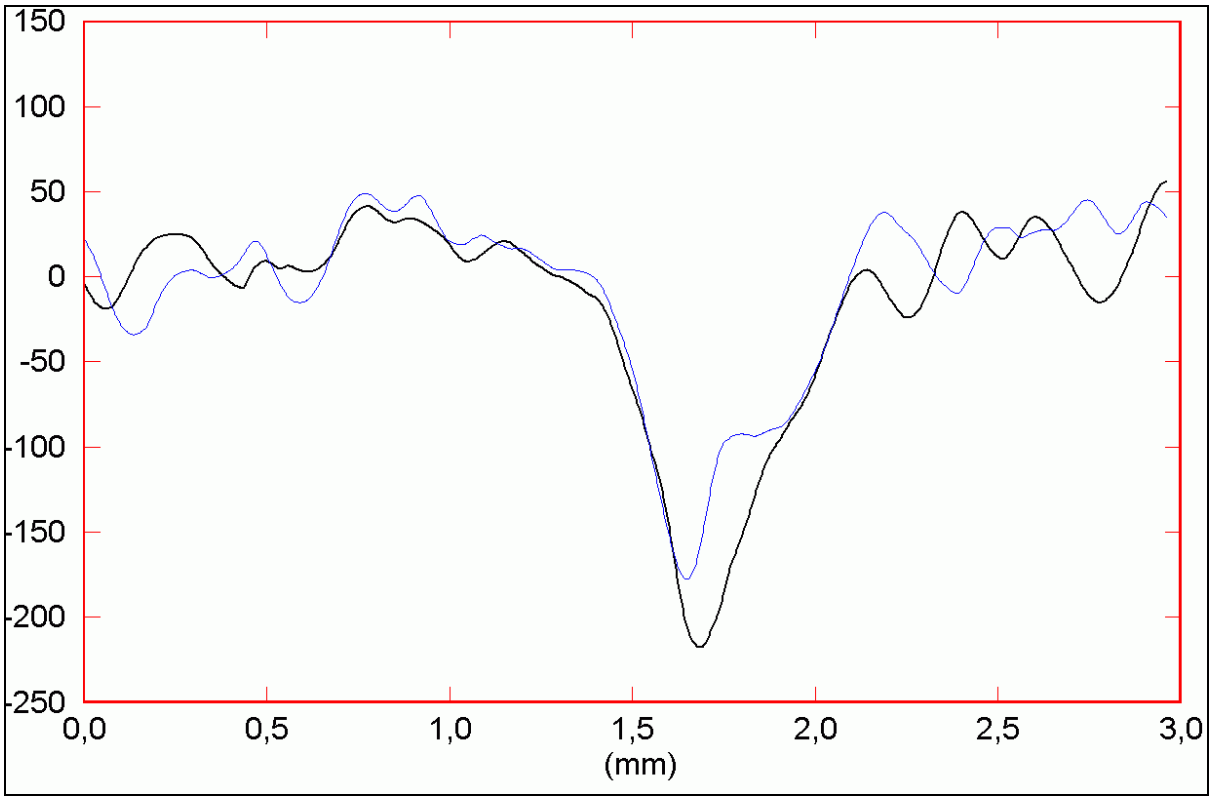
Img. 1.37 Adoption of intersecting lines into all images

Display Profile of the intersecting line

The 2D diagram of the intersecting line can be called up by clicking on the program symbol.


PRIMOS - [Reference file: Augenf~vorher_.omc Comparison file: Augenf~nachher.omc]
File Edit View Settings Applications System Window About

Img. 1.38 2D diagram tool

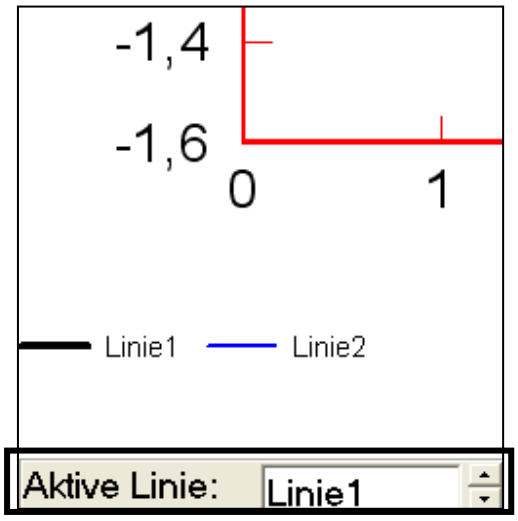


Img. 1.39 2D Diagram of the intersecting line

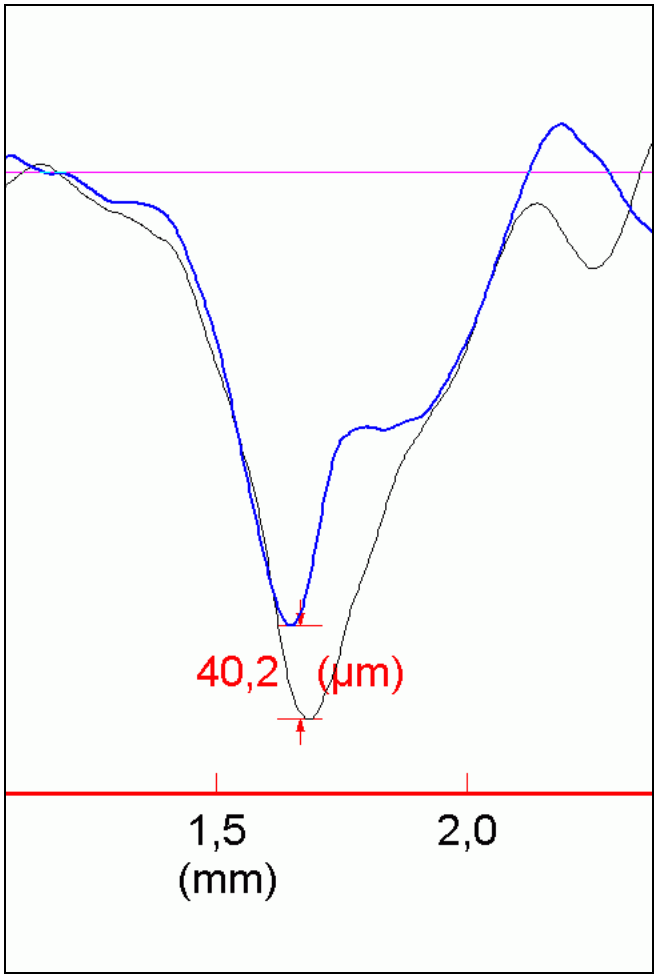
In the 2D diagram, the course of the 2 lines is clearly discernible. Through the treatment, the deepness of the wrinkle under observation has decreased. By laying down marking points, it is now possible to measure the distance between both lines.

At first you have to put a point onto the active line (represented thick). Then put the second point onto the second line, therefore the active line must be switched. On the bottom right corner of the screen there is a drop down menu where the active line can be changed.

After laying down the second point onto the second line, the measurement of the difference in height can be displayed through a single click on the program symbol in the icon list.



Img. 1.40 choosing the active line



Img. 1.41 Profiles of the height difference**.**

2. Introduction

The three-dimensional recording and evaluation of the surface structure of the human skin is an important task in dermatological examinations, under medical as well as cosmetic aspects. So exact diagnosis, therapeutic decisions as well as medical and cosmetic advances in treatment are generally only possible with exact knowledge of the 3D surface structure of the skin. Despite several years of successful use of mechanical scanning surface measuring systems for surface profile measuring of skin imprints (replica), there is an increasing demand from the cosmetic as well as from the medical branches to perform 3D measuring directly on living human skin surfaces. For one, more exact information about the structure of the skin surface is expected with in vivo measuring of the skin surfaces. Further, in vivo measuring of course represents a significant timely and, therefore, commercial advantage in comparison to the conventional imprint methods. Disadvantages to be expected with 3D measuring of the skin surface by means of imprints result especially from:

- Contact-method measurement methods can render invalid data when measuring damaged skin and/or healing wound sites;
- Patient / Test person discomfort due to the application of the silicon;
- Use of replica causes changes of
- the skin surface profile, when replicas are made, possibly causing deviations in measuring results when determining quantitative surface parameters (e.g. roughness values);
- Until present, mechanical contacting surface measuring procedures scanned the made replica in a line pattern and so the recording of a 3D profile report is an extremely time consuming process

Based on the disadvantages described above, intensive work on development and construction, as well as application of optical 3D surface measuring systems for 3D in vivo skin measuring has been performed. The following advantages can be expected with the use of optical 3D in vivo skin measuring technologies:

- The measuring of the living skin surface is contact-free, without disturbing patient/test person and without possible falsifications.
- The direct and fast measurement on the skin surface represents a significant time saving and, consequently, a reduction of costs.

- The measurement and recording of a 3D measuring report with several hundred thousand measuring points takes only a few seconds.
- Operating errors can be minimised for periodical measurements with an automated computer-controlled procedure, from measuring data recording to output of the results on the computer monitor or on a connected printer.

Optical 3D measuring techniques used for the 3D in vivo skin measuring should fulfil the following essential criteria:

- Data recording has to be accomplished within a few milliseconds or directly in video real time.
- Light sources with sufficient light intensity have to be used, to allow the application of colour or polarisation filters for lighting, if necessary.
- Light intensity has to be controllable, to allow light adjustment for different skin types/ complexions as quickly as possible, and to achieve comparable measuring results.

Developments and tests for application of the optical 3D measuring technology, based on digital stripe projection with micro mirrors, have been implemented since 2000 in cooperation with the Dermatological Research Department of Beiersdorf AG, Hamburg, the Research Department of Henkel KGaA, Duesseldorf, the Philips Research Center, Personal Care Institute, Eindhoven as well as the University of the German Armed Forces, Institute for Automatization Technologies, Hamburg. These have resulted in the creation of the optical 3D in vivo skin measuring system PRIMOS (**P**haseshift **R**apid **I**n vivo **M**easurement **O**f **S**kin), fulfilling all the requirements of a modern 3D in vivo skin measuring.

The optical method used for measuring is the digital stripe projection technique, based on digital micro mirror projectors (**DMD**^{TM}: **D**igital **M**icro mirror **D**evices) of Texas Instruments/ USA. Stripes with sinusoidal intensity of brightness are projected onto the surface of the measuring object and its projection (the stripes changed by the height profile of the measuring object) is recorded with at a defined triangulation angle by a CCD camera. The topography of the measuring object is calculated from the stripes position and the grey value of all registered individual image points. Depending on the concrete measurement task different stripe projection procedures can be used.

Basic advantages of the optical 3D in vivo skin measuring system PRIMOS are the contact-free measuring data acquisition, a high measuring rate, a high resolution and accuracy as well as the

ease of use. Short measuring times (≥ 68 ms/frame) guarantee a small influence of involuntary movements of the patients/ test persons to the measuring results.

Hints:

We have to point out that the used names of the several firms in general are under the trade mark, mark or patent protection law.

Great care has been taken to ensure the quality and accuracy of the data contained in this manual. Nevertheless errors are possible. LMI neither guarantees for correctness or technical accuracy of the contained specifications; nor does LMI accept responsibility or any accountability for consequences of misinterpretation of this document, which may or may not be caused by faulty statements contained herein.

LMI Technologies GmbH reserves the right to change the manual or software in sense of the technical progress.

Please note, that depending on the software version purchased with the measuring system, some program features may not available!

3. Configuration of the Measuring System

Img. 3.1 gives an overview of the basic configuration of the optical 3D in vivo measuring system PRIMOS*lite*.

Img. 3.1 Configuration of measuring system: sensor with stand, measuring computer

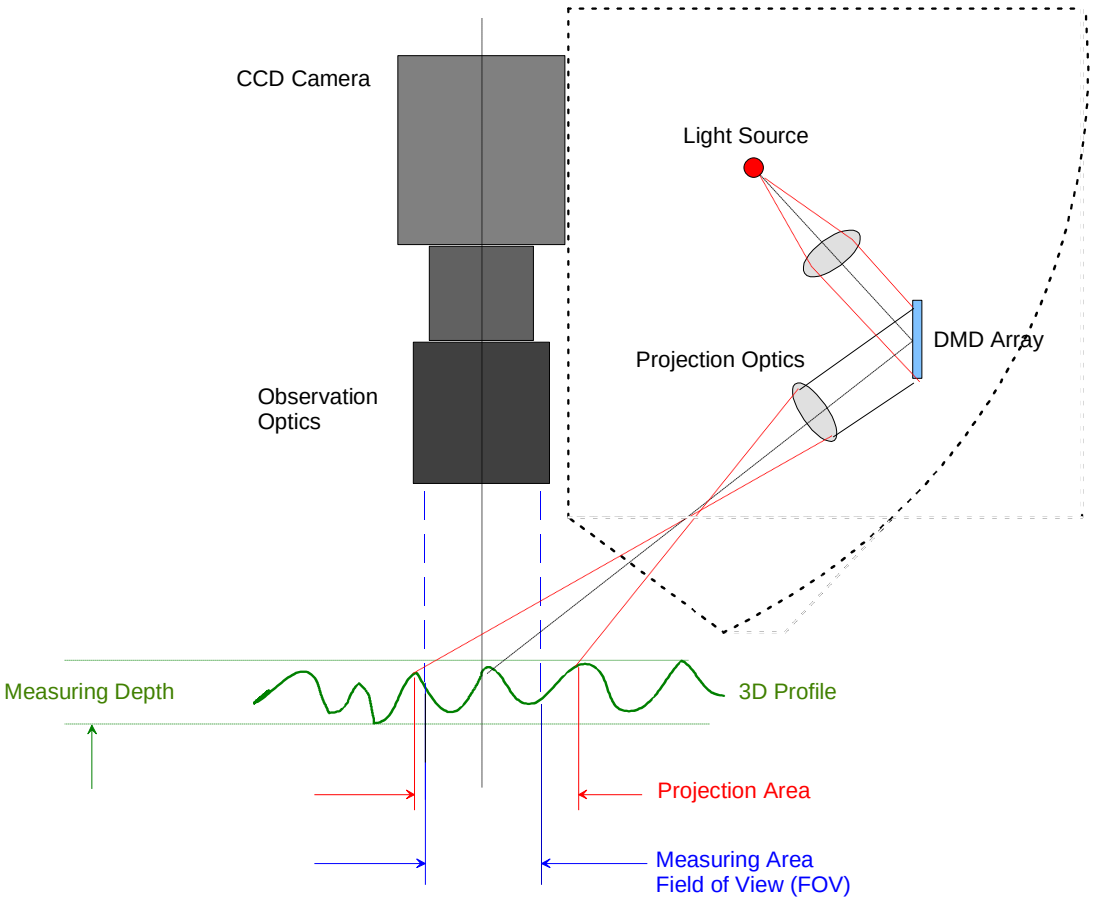
Scope of delivery:

1) Sensor with stand for deposition of the sensor and electricity supply of the sensor

2) Measurement and evaluation note book 3 button mouse.

3) Spacer

The functional structure of the optical 3D sensor (1) is shown in the principle picture in Img. 3.2



Img. 3.2 Principle depiction of optical 3D sensor

In the sensor, the projection and recording optics, the CCD recording camera and the DMD projector are integrated as well as boards for its control.

4. First Installation

4.1. Mounting of optical 3D sensor and measuring system

For precise measurements and the prevention of damage to the mechanism and the optical system, the following environmental stresses have to be avoided:

- Large fluctuations in temperature
- Strong vibrations
- Strong magnetic fields
- High humidity.

Img. 4.1: Optical 3D sensor PRIMOS compact

Direct sun light or direct illumination on the measuring area leads to a more uncertain measurement result (noise) and should be avoided. Overhead room lightning should be turned off and if necessary a small desk lamp used for basic lightning.
The use and storage of the measuring device in any type of aggressive environment is not permissible.

When setting up, make sure there is enough distance between system components, walls or furniture etc.. All ventilation louvers should be kept clean, (back of PC) and no liquids should in any way enter, in particular when cleaning the system.

4.2. Power Supply

- The power supply of the systems is configured by the manufacturer according to the local needs in the country of the customer. No further settings are necessary or should be done by the user.
- Before using the measuring system for the first time please check the current voltage settings, especially if the system was transported to another country without the knowledge of the manufacturer. If you are not sure about the necessary settings contact the manufacturer.
- Incorrect voltage may damage the device or its components.

4.3. Connecting of Cables

Before the first start-up of the measuring system or after its installation at a new place all cables must be connected. Switching the plug and socket connections is not possible as the connections are different. Connect the cables as describe in the hard- and software installation manual.

4.4. Control Board and Measuring Software

- The control boards and the measuring software are a part of the measuring system. They are preinstalled and tested.
- The Installation of further hardware components onto the measuring PC as well as the change of the measuring computer can lead to malfunctions in the measuring system and so should always be done by the measuring device manufacturer or their service representative.
- At the first installation or after transportation of the measuring system a calibration (or at least a check of calibration) has to be performed.

4.5. Starting up the Measuring system

After producing all necessary cable connections between the components of the measuring system, as well as their main power supply, the measuring system can be started up. For this purpose, the following operations are carried out in the given order:

- Switch on measuring, control and evaluation computer
- Open measuring, control and evaluation program

4.6. Turning off the Measuring System

To switch off the measuring system after finishing the measurements, the following steps should be undertaken in the given order:

- Close measuring, control and evaluation program
- Switch off measuring, control and evaluation computer
- Switch off the sensor on the small button on the top of the sensor

4.7. Installation / un-installation of the measuring, control and evaluation software

The measuring, control and evaluation program can be installed and un-installed in a simple manner. To install the software, undertake the following steps:

- Open the **Explorer** from MS-Windows
- Insert the installation disc 1 / CD into the appropriate drive of the PC
- Change to the corresponding drive and open the file **setup.exe**
- Follow the instructions of the installation program
- After completing the installation, remove the installation CD / Disk from the drive

To uninstall the measuring, control and evaluation software, undertake the following steps:

- Select the menu item **Start** | **Settings** | **Control panel**

- In the control panel menu, open **Software**
- Select **Primos** in the software list under **Install/uninstall**
- Click on **Add/Remove**
- Confirm the computers query regarding deleting the software.
- After completing the un-installation, click **OK**.
- To close the **Software** menu, click **OK**.
- To close the control panel, click the button close,
  or in the top right corner of the screen.

4.8. Starting and Ending the Measuring, Control and Evaluation Program

To start the measuring, control and evaluation program, undertake the following steps:

- To start click **start** and move the curser over **programs**. Then move the curser over **PRIMOS** and click on the button **PRIMOS**

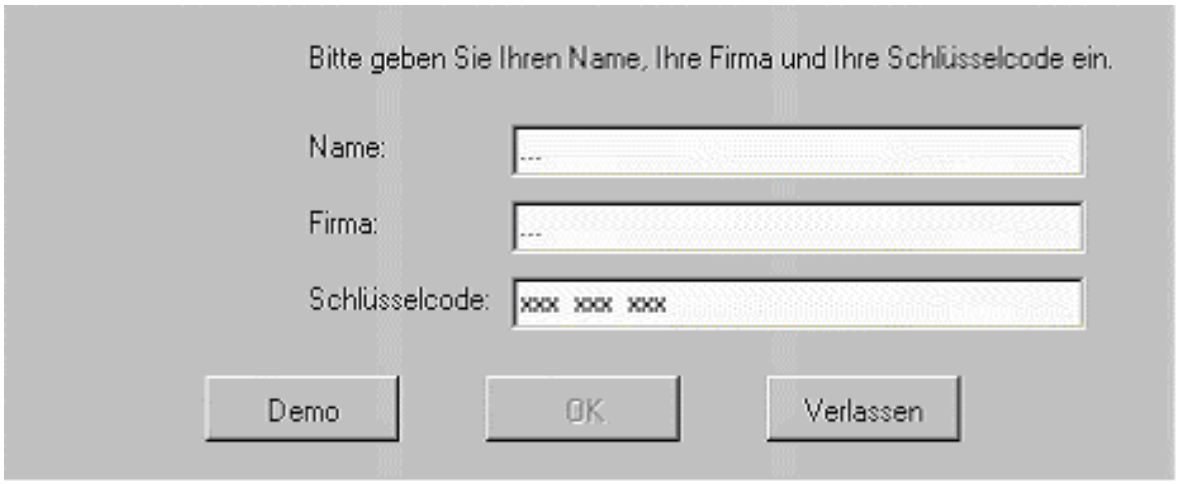
Or

- Click on the **PRIMOS**-Symbol on the desk top.

To close the program and all its windows, click in the top right corner of the screen on the button Close.

4.9. Entering the Key Codes

During the first start of the PRIMOS software, after the installation, a window appears for the insertion of a key code. Here please enter the name of the user, the company name and the key code delivered with the software and subsequently confirm the entries with “Enter“. If the key code is correct, then the button **OK** becomes active. By activating this button, the program opens. With a wrong or missing code, the only possibility is to start the program as a DEMO Version (Click **Demo** button).



Img. 4.2: Request for key code during first start of program

4.10. Transporting the Measuring System

Before any shipping or transport, all components of the measuring system must be carefully packed. During transportation, all system components must be handled with care. Especially strong mechanical vibrations, shocks, bumps etc can cause de-adjustments which can impair future measurements. Mechanical impacts such as dropping the system can lead to the destruction of delicate building parts.

For a first installation after the transport, a calibration of the measuring system or at least a calibration check is necessary.

Hint:

Camera and projection optic are aligned to one another with a high angle precision. The impact of forces on the video camera and projection optics must be prevented at all costs. Adjustments to the measuring system can only be undertaken by trained technical personnel.

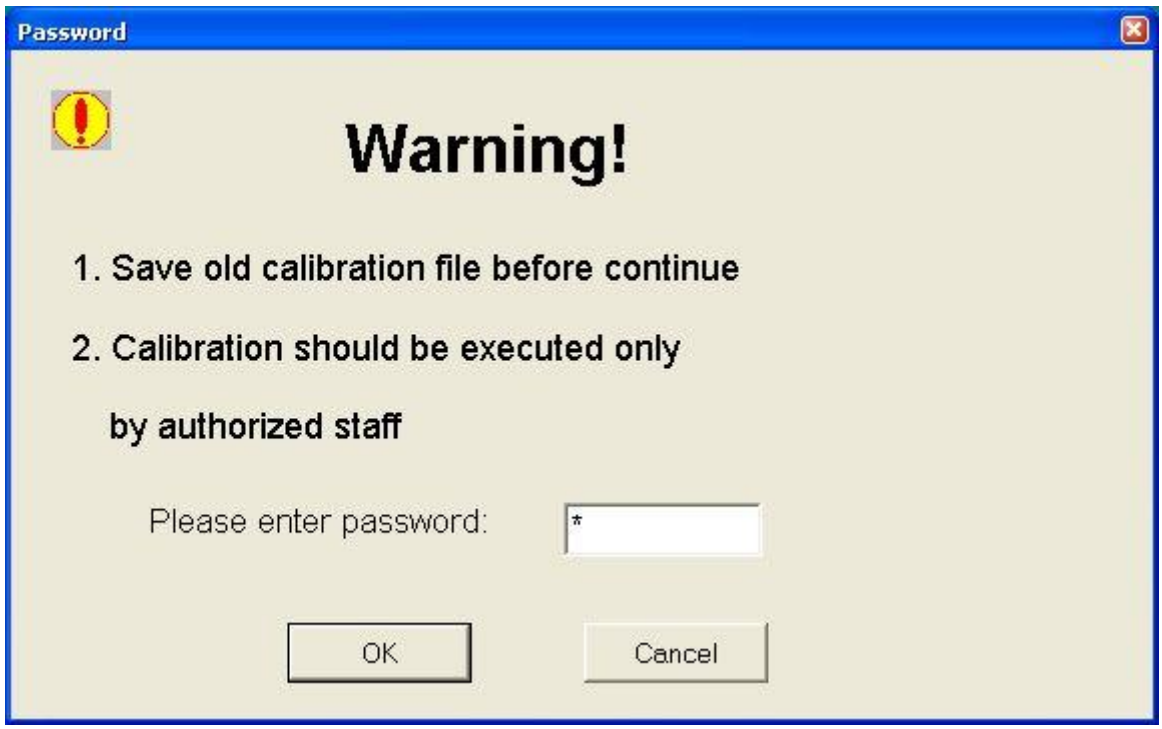
The LMI Technologies GmbH is not liable for any damage to the system through improper transportation.

5. Calibration

5.1. Basic system configuration

It is recommended to save the old calibration files before performing a new calibration. For this copy all files with the format **".sys"**, **".ini"**, **".cfg"** and **".fcf"** located in the PRIMOS program directory to a backup directory.

For the calibration of the measuring system, a step or groove normal and a cross grid are required. The parameters of the adjusting pieces are to be input in the PRIMOS system configuration. To check these parameters select the menu point **System | System settings**. The calibration program as well as the measuring program must be closed for this. After entering the password, the window for input of system settings opens. The primary password at delivery of the measuring system is the character "**a**".

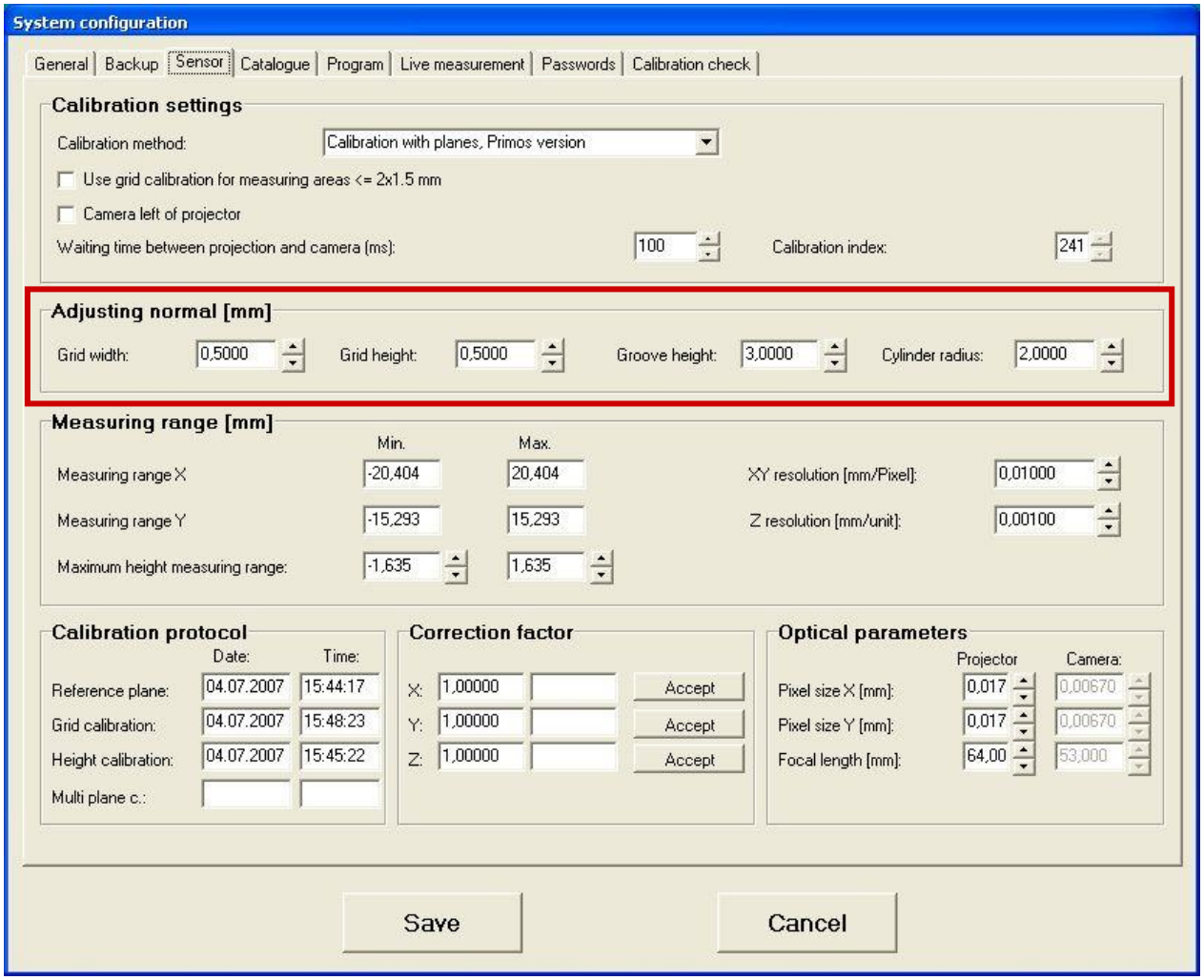


Img. 5.1: Password request

Password changing

It recommended to set an individual password in the area of **passwords** in the menu **System | System settings**.

Select the menu **System** | **System settings** to check the basic configuration parameters. In the tab **Sensor**, the parameters of the measuring instrument calibration tools, i.e. grid width, grid height and step gauge which are delivered with the system must be entered (see fig. 5.2). The basic adjusting normal parameters in the PRIMOS system configuration must be corrected if they do not correspond to those on the delivered calibration tools.



Img. 5.2: System configuration

5.2. Start Calibration

After the parameters of the adjusting pieces were checked or corrected, the calibration can be started by clicking on the icon marked in fig. 5.3 or the button **Applications | Start calibration**.

Img. 5.3 Start Calibration

To protect the calibration from unauthorised changes, the password is again required (see Fig. 5.1). Take into consideration that the new password must be entered if you changed it.
The calibration is performed once in 3 steps for all different measuring modes, i.e. calibration of reference flat, elevation calibration and lateral calibration. Furthermore alongside the calibration program, the synchronisation of projector and camera will be carried out. In case that the calibration was performed incorrectly and you would like to retain the previous calibration, select the menu point **Calibration | set calibration back** before closing the calibration window.

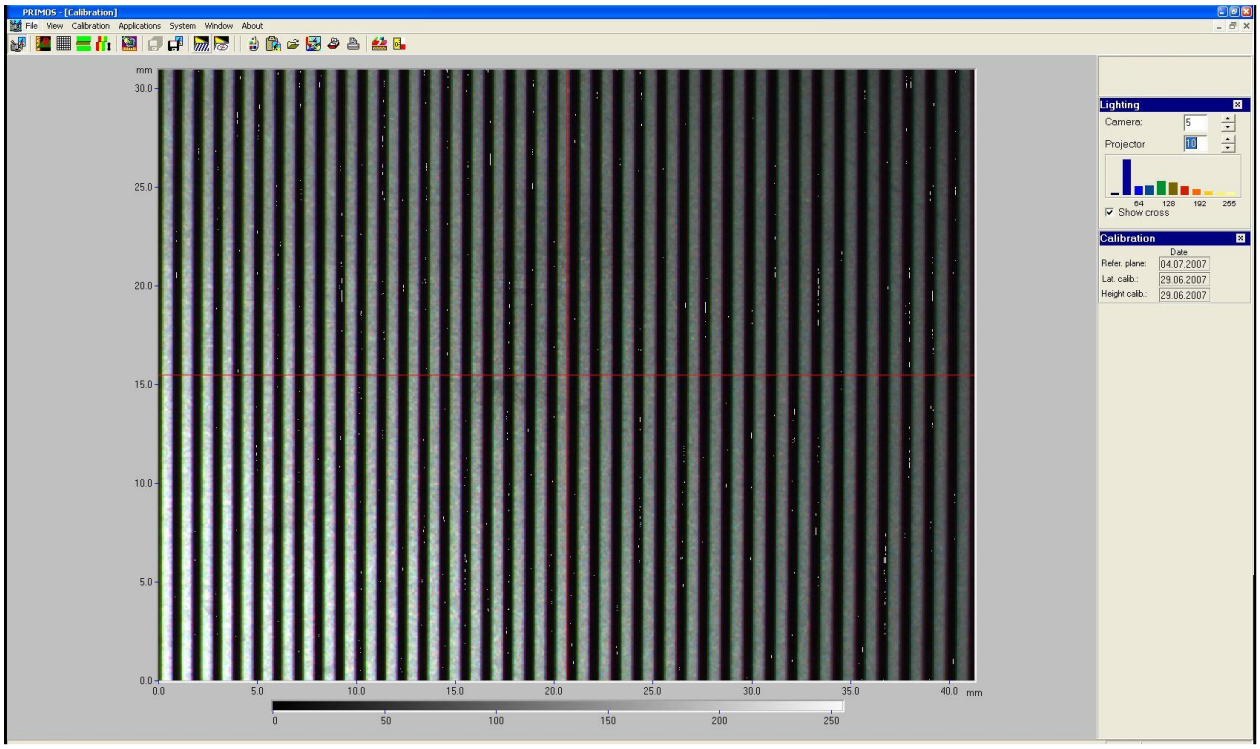
Calibration condition:

- Pay attention to the lighting. The calibration must occur in a room where no sunlight can influence the system.
- Touch the calibration tools **only** with gloves.

5.3. CALIBRATION OF THE REFERENCE FLAT

For calibration of the reference flat a flat surface is needed. It is recommended to use the front side of the step gauge without the channel or the step being in view of the recording window.

Before the calibration of the reference flat, the live image must be carefully focused because later on during the measurements, the shapes are projected in focus onto the centre of the reference flat. This makes it possible in future measurements, to focus the image quickly using a crosshair. Please make fine stripes visible on the surface (by repetitive clicks on the “project stripes” button – fig. 5.4).



Img. 5.4: Camera picture of the reference flat with stripes

Procedure:

Enable the live picture (icon or button **Calibration | Live picture start/stop**).

Position the backside of the step normal in the measuring field (it should be seen in the whole live picture).

Project stripes (click icon and repeat clicks or select stripe width in the menu **View | Stripes/ …**) and focus the sensor (stripes should be as sharp as possible – see fig. 5.4).

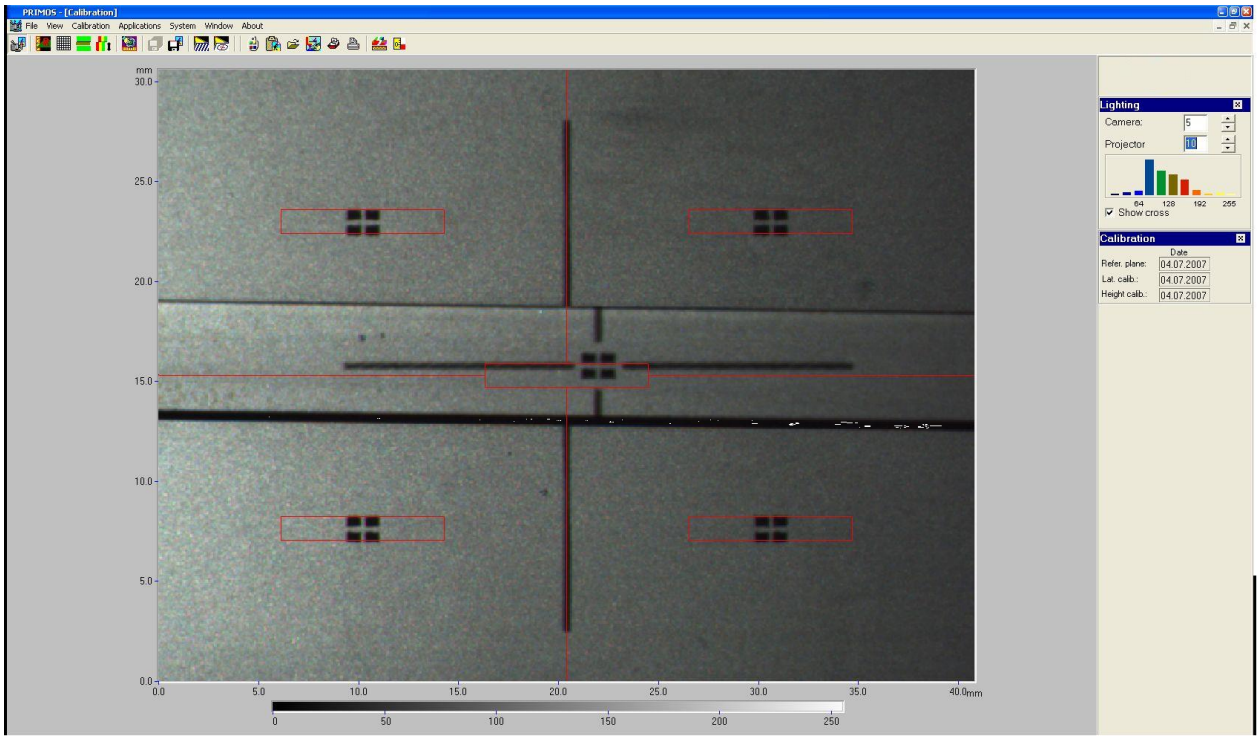
If necessary, correct the brightness from the light source.

Start the calibration of the reference level (click icon or button **Calibration | Determine reference plane**).

All points of the surface with equal separation distance and spatial orientation to the measuring sensor are set to a neutral level. Closer points are assigned higher levels during a measurement, even if the optical measuring sensor is tilted.

5.4. Vertical calibration

The next stage of the calibration will be the elevation calibration using the step gauge normal.



Img. 5.5: Camera picture of the step gauge normal with the reticule pattern

Procedure:

Enable the live picture (icon or button **Calibration | Live picture start/stop**).

Position the groove in the middle of measuring window.

Align the groove parallel to the x-axis of the blended in cross in the middle of measuring window.

Focus the live picture; for focussing it is recommended to project a pattern (e.g. a cross - click icon or button **View | Pattern | Cross**).

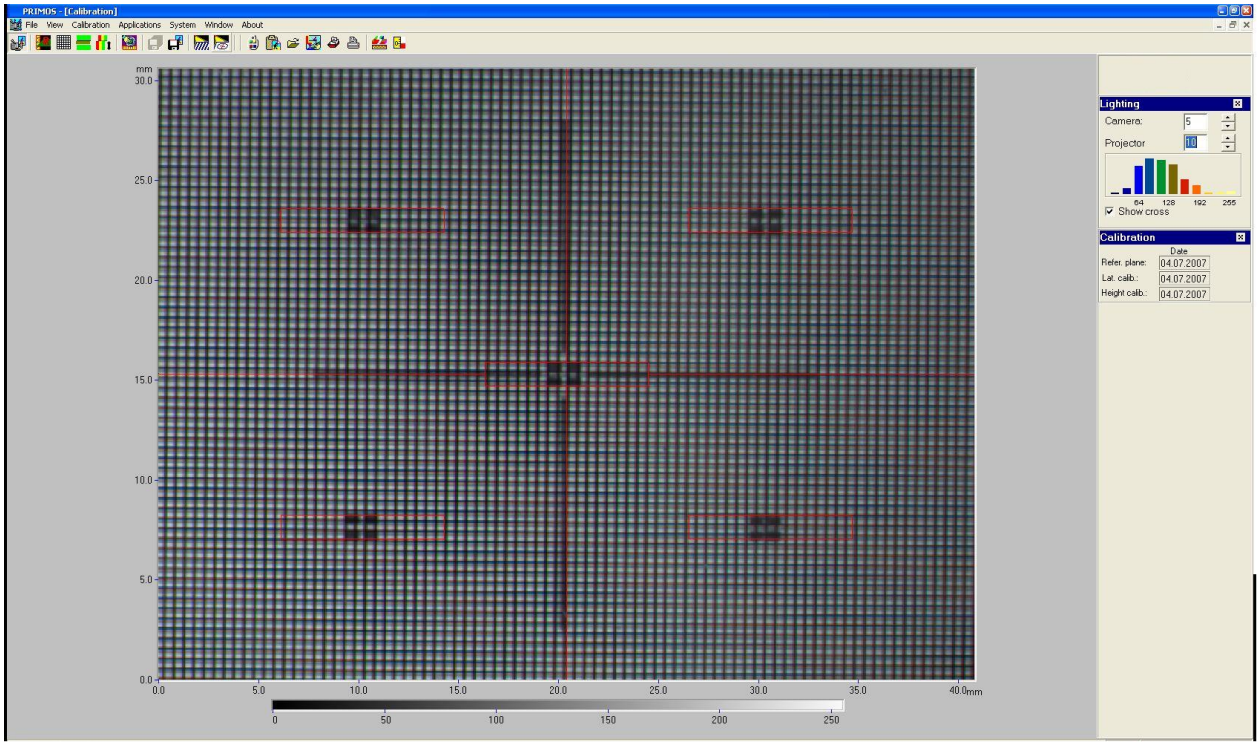
If the distance is changed “sensor – surface to be measured (= height change)“ the position of the projected cross will change. When the projected cross and reticule match the optimum focus is achieved (see fig. 5.5).

If necessary correct the brightness.

Start the height calibration (click icon or button **Calibration | Start height scaling with corrugation**).

5.5. Lateral calibration

For lateral calibration, the cross grid is used. In this calibration procedure all points of the camera picture are treated by Fourier filter and the separation distance between the points on grid is evaluated with subpixels precision.



Img. 5.6: Lateral calibration by using of cross grid

Procedure:

Enable the live picture (icon or button **Calibration | Live picture start/stop**).

Position the cross grid in the middle of measuring window (it should be seen in the whole live picture).

Align the grid parallel to the reticule.

Focus the live picture (fig. 5.6).

If necessary correct the brightness.

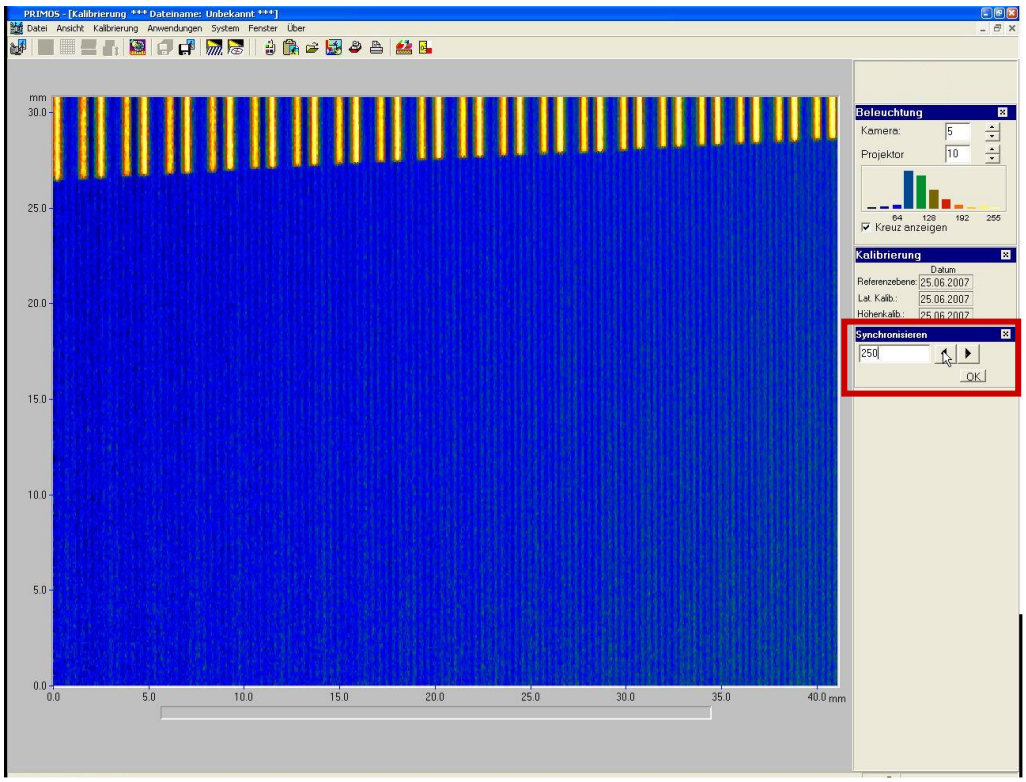
Start the lateral (x-y-) calibration (click icon or button **Calibration | Start lateral scaling**).

All calibration parameters will be saved automatically when the calibration window is closed. The calibration can be checked by a test measurement of the adjusting piece (step gauge - click icon or button **Calibration | Start test measurement)**. The live picture can be frozen by means of

the icon or the button **File | Save camera picture** and then stored like the measured height picture using the icon or the button **File | Save height picture**.

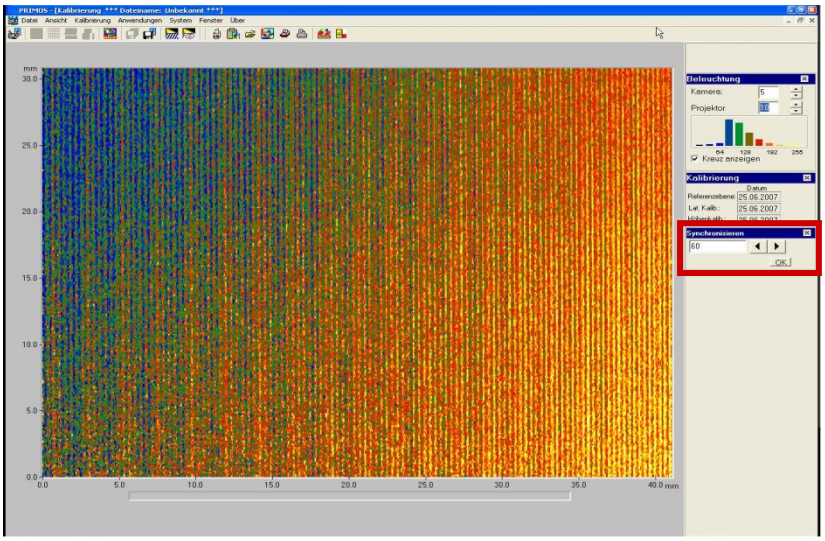
5.6. Synchronisation

The recording process of the camera and the stripe generation of the projector must be synchronously performed. To perform this synchronisation, put a plane under the optical sensor and focus the sensor (see fig. 5.6). To start the synchronisation click the icon . If the synchronisation is incorrect, a colour mismatch in the height picture or a striped height picture will be seen (see fig. 5.7).



Img. 5.7: Incorrect Synchronisation

The synchronisation value can be changed using the up/down button until the colour mismatch or the stripes in the height picture are eliminated (see fig. 5.8). Confirm the adjustment by clicking **OK**.



Img. 5.8: Correct Synchronization

5.7. Calibration test

The new PRIMOS version will include an automatic calibration check. The user will be guided though a procedure and receives a green

or red

light for the calibration.

The test buttons are on the toolbar of the measuring program.

The green light means that the calibration is within the specified tolerance. The red light means that, to be on the safe side, the calibration should be repeated. Furthermore, an information

window was installed which shows the dates of the last calibrations.

To finish the calibration process, close the calibration window.

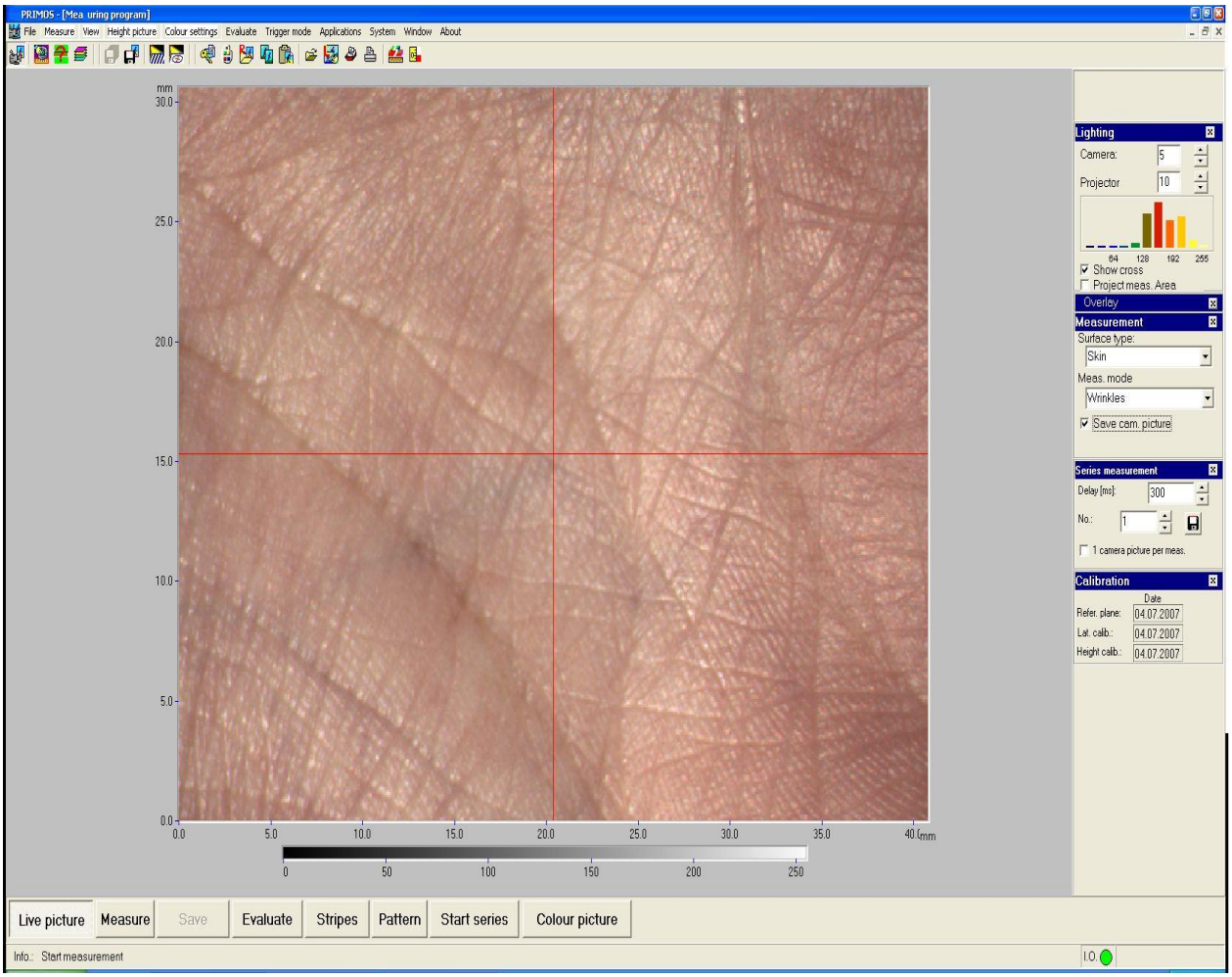
Further information on how to use the functions of the menu “Calibration” is also included in chapter 20 “Brief description of the program functions in the measuring, control and evaluation software – Toolbar”.

6. Measurement

6.1. Start of measuring program

The measuring program is opened using the menu point **Applications | Start measurement** or the button .

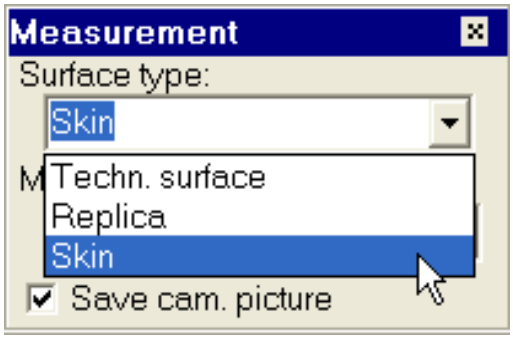
If the test person database is activated a window appears where you will be asked if you want to use it. More information about the test person database can be found in chapter 15.



Img 6.1: User interface in measuring mode

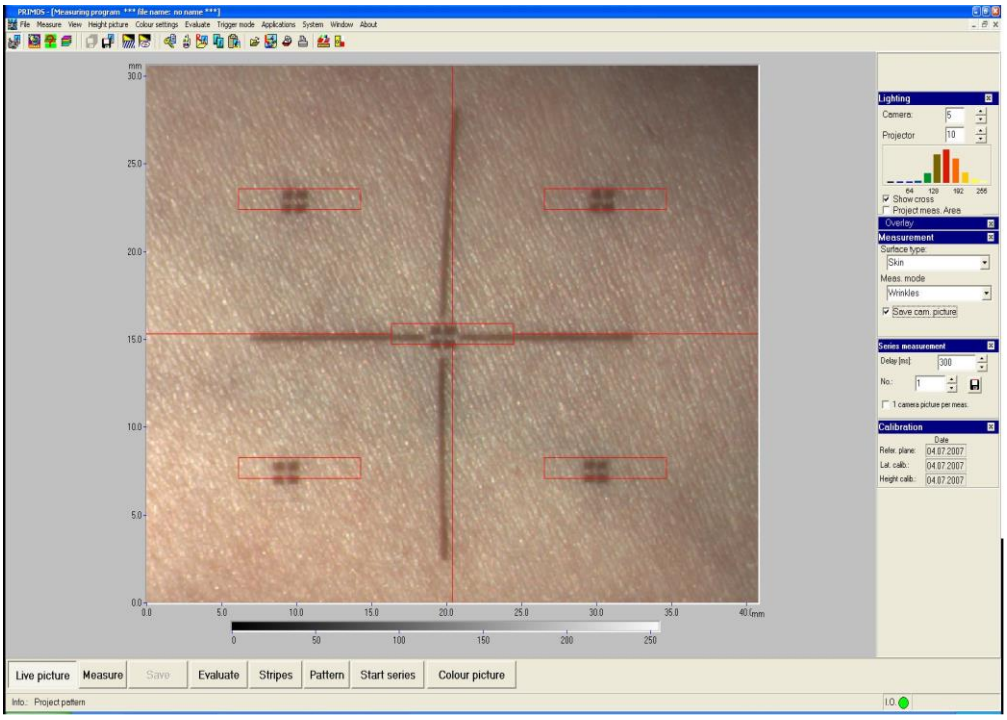
6.2. Preparation of measurement

After starting the measuring program, the appropriate measuring mode for the object to be measured must be chosen. For this purpose, a selection box is available at the right side of the window.



Img. 6.2: Selection of measuring object

The corresponding measuring modes are predefined by LMI and differ regarding number of frames, stripe width and evaluation mode (phase shift; grey code + phase shift; phase shift with different stripe widths).
The measuring modes are adapted to the measuring tasks regarding measuring time, accuracy and sensibility towards disturbances.



Img. 6.3: Camera image with projected pattern cross

After selection of measuring object the live image has to be enabled (icon or button **Measure | Live picture start/stop**) and focused. For focusing change the distance between the sensor and the measuring object.

To aid in the focusing, a pattern can be projected onto the surface by clicking on the button **Pattern** or the button **View | Pattern** or the icon . To blind out the pattern simply click with the mouse on the live picture.

If the distance between the sensor and measuring object is changed (z-axis) the projected cross will move. As a help whilst focusing a reticule can be enabled in the measuring window by selecting the appropriate option in the selection box of the measurement settings (“Show cross” at the right border of window). An optimal focus is reached when the projected cross is right in the middle of the live picture, e.g. if the projected cross and reticule match.

The projected cross is displayed in such manner that it is located in the middle of the calibrated reference level. If the camera image is not in focus when the projected cross is located in the middle position, the measuring device has to be re-calibrated.

For different colours or reflectivity of measuring object surface the brightness of the live picture has to be appropriately adapted. The software continuously reviews the correctness of the brightness adjustment by itself. In the case of correct brightness, the indicator at the lower right of the program window will be green, in the case of incorrect brightness it will be red, i.e. a change of brightness is necessary.

The **adjustment of brightness** should be made at **middle position of lens aperture**. **Lighting** should be reduced as much as possible (test parasitic influences of fluorescent tubes and energy saving lamps); the comparison of **roughness measurements** is only possible with **comparable adjustments of lens aperture and camera enhancement**. For this reason; **save** screenshots of all **measuring parameter adjustments** as far as possible (also system adjustments) to ensure reproducibility!

6.3. Height measurements

After selecting the measuring mode, bringing the measuring device on focus with the surface to be measured and adjusting the brightness, the 3D measurement can be performed. For the performance of the 3D measurement, the following functions are available in the measurement window:

Live picture or

or **Measure | Live picture start / stop or push activator**

By means of this function the camera image will be transferred to the monitor. The live picture must be enabled before measurement or, respectively, projection of stripes or pattern.

Measurement - or

or **Measure | Start measurement or push activator**

Starting a single measurement. During measurement the transfer of live image will be interrupted. After the measurement is finished, the 3D data will be shown colour coded on the monitor.

Save - or

or **File | Save height picture**

Saving the measured height picture. Thereby, an appropriate file name must be entered. If the field “Save cam. pic.” is enabled then the corresponding camera image will also be saved each time. It receives the same file name as the height picture and the file ending .kam. If a concrete camera image has been explicitly saved, it must firstly be frozen (button **File | Save camera picture** or icon) and then saved like a height picture (buttons **File | Save height picture** or **Save** or icon).

Stripes - or

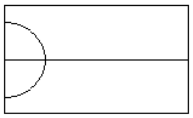
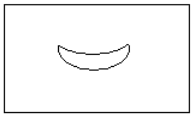
or **View | Stripes | ...**

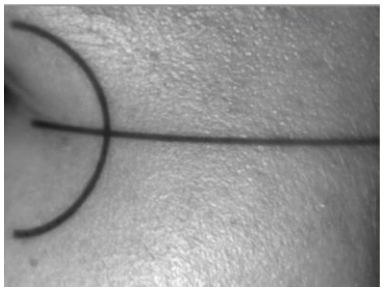
Projecting stripes. The camera image with projected stripes is shown on the monitor. By repeated mouse clicks on this functional button, the number of stripes doubles each time. Projected stripes can be used for the assessment of depth, focus and illumination.

Pattern - or

or **View | Pattern | ...**

Projecting pattern (eye wrinkles left, eye wrinkles right, eye bags, cross, rectangle, circle and combinations). The camera image with the projected pattern is shown on the monitor. By repeated mouse clicks on this functional button, different patterns are projected. Because the pattern is projected onto the middle of the calibrated reference level it can be used for height adjustments (focussing) of the measuring system.

The newly available patterns eye wrinkles  and eye bags  are projected on the skin and saved on the *.kam image. That makes it much easier to locate the same area of the skin for multiple measurements. By using the overlay function (see chapter 7) the *.kam image with the imprinted pattern can be deposited transparently and aligned with the pattern that is faded in just now.



Img. 6.4 *.kam image with the imprinted pattern “eye wrinkles left”

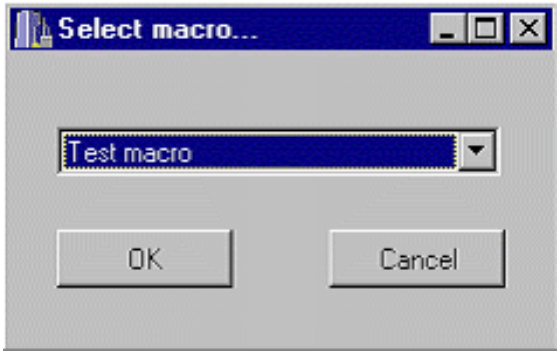
Series measurement - or

or **Measure | Start series measurement**

In the case of a series measurement, several successive single measurements are performed. Following this, the calculation of the height images occurs. The height images are displayed in the gallery mode to provide an overview. The height pictures are saved under the same name with a sequential number always added at the end. Especially when the fixing of the measuring object to the sensor is difficult, the series measurement offers a high probability that a part of the measurements is performed error-free. The number of measurements to be performed in series as well as the time interval between each measurement can be set in the control field of the measurement window below on the right.

Automatic macro activation directly after measurement

For frequently used evaluation methods, it is possible to activate a stored macro after each measurement. By selecting the menu item **Evaluate** and then **Start macro file after measurement,** the automatic run of a macro can be enabled. In the combo box, select the appropriate macro and confirm with **OK**. Now, if a measurement is performed, the macro will be run afterwards automatically.



Img. 6.5: Popup for activation of automatic macros

6.4. Change to interactive evaluation

For the interactive evaluation of the height picture it is necessary to transfer the 3D data to a new window, the work area. For this select the menu item **Applications | Take height picture into work area** or click the icon . After this, the complete functionality of the PRIMOS software for the interactive evaluation of the 3D data is available.

Further information on how to use the functions of the menu “Measurement” is also included in the chapter 20 “Brief description of the program functions in the measuring, control and evaluation software – Toolbar”.

7. Overlay

The overlay function is an aid for the easy recognition of measured skin areas. Thereby, the stored camera picture of the first (reference) measurement is faded into the current camera picture (*Overlay*). Through this, it is possible to adapt the live image to reference skin area of the original measuring position. This rough approximation is the ideal basis for the later “3D Matching“.

The following steps are to be performed for the use of the overlay function:

Open the measuring program.

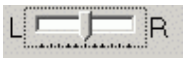
Select and open by means of the menu item **File | Open reference picture** or the icon .

Enable the live picture (or

or **Measure | Live picture start / stop**).

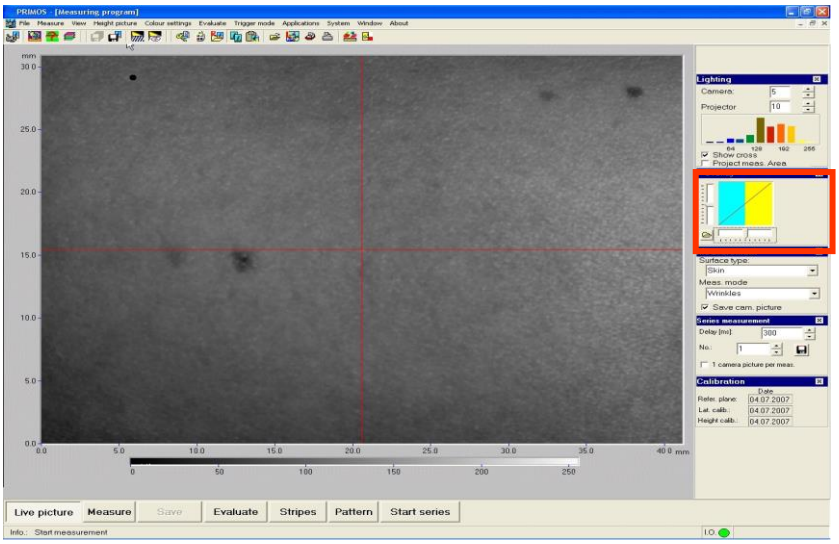
By means of the menu point **View | Start / Stop overlay** or the icon fade in the reference camera picture.

At the right border of the window, the overlay function bar which allows the control of the following parameters, will be displayed:

- Contrast/ cross-fading between live picture and reference camera image 

- Total brightness

Bring reference camera picture and live picture to match as closely as possible and perform the measurement taking into account the chapter “Measurement“.

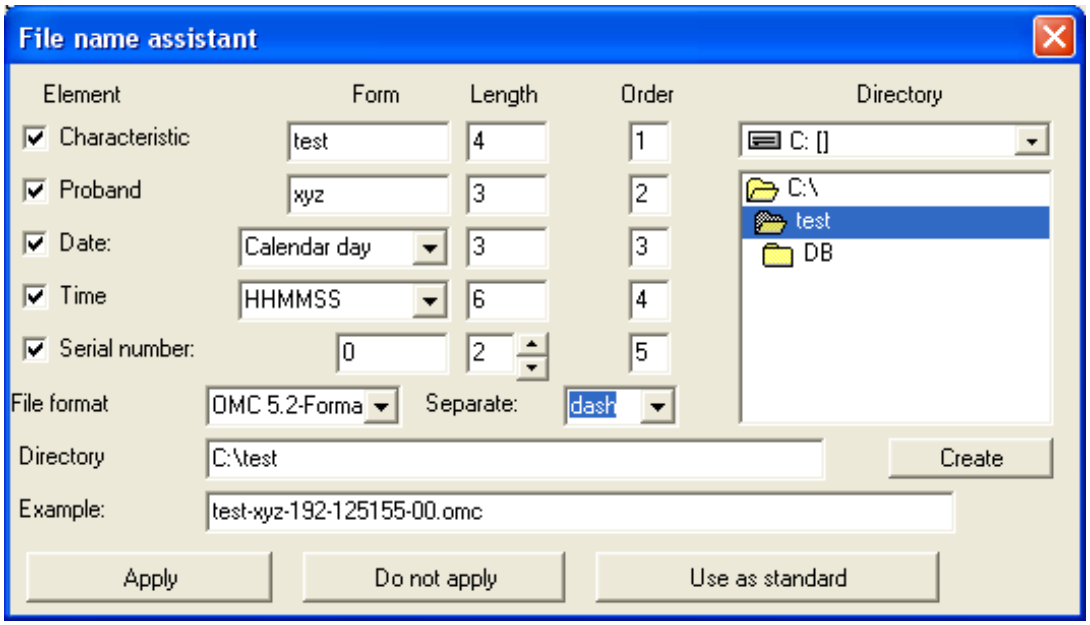


Img. 7.1: View of overlay configuration

8. Naming Assistant

For the saving of measured height pictures, the possibility stands, to make use of an automatic file naming function.

For this, open the naming assistant window in the measuring program (under **File | Naming assistant** or by clicking the corresponding icon)



Img. 8.1: File naming assistant Popup

The name can be built together out of different components. These components can be modified in **form**, **length** and **order**.
In the field **form**, the description or form of the name component will be indicated. In the field **length**, the number of characters will be determined. In the field **order**, the position of the corresponding name component in the complete file name will be determined.

Components of names:

Characteristics - (text field - enter characters)
Test person (proband) - (text field - enter characters)
Date - (select form of presentation)
Time - (select form of presentation)
Serial number - (determine starting number)
File format - (select file format)

Seperate - (select type of component separator within the complete name)
Directory - (can be selected or created)
Example - (shows the complete name currently selected)

In the field “Directory” in the right side of window, the directory for the storage of measuring data can be selected. If required a new directory can be created by selecting the path in the above mentioned field, adding the name of the new directory in the field “Directory” left of the button **Create** and then, clicking this button.

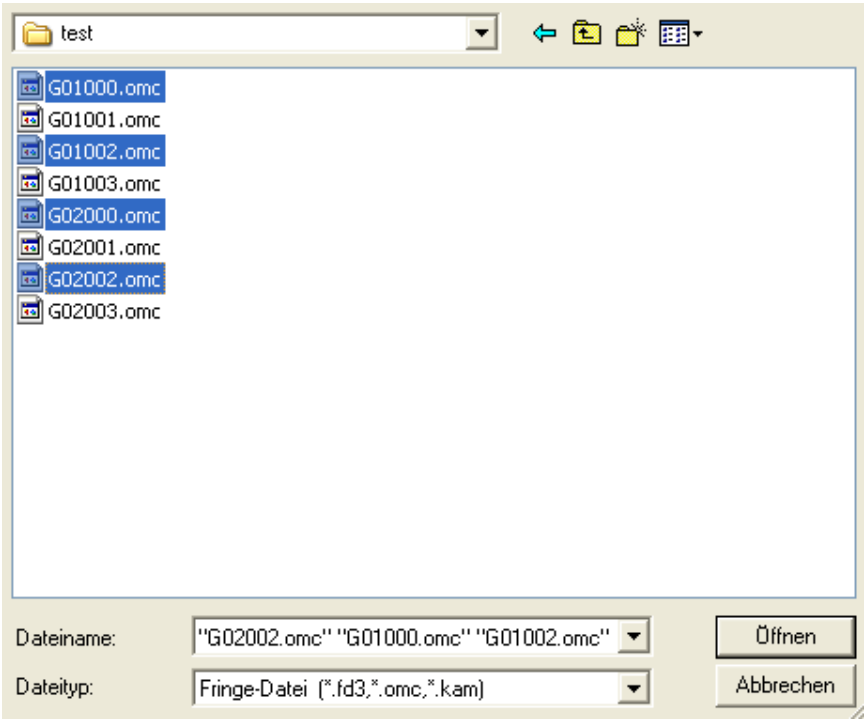
By pressing on the button **Apply,** the automatic file naming is activated. By clicking **Do not apply,** the operation will be cancelled. Furthermore, you have the possibility to define the settings as standard (**Use as standard**).
When the naming assistant is enabled (button **Naming assistant** is marked and the appropriate icon is “pressed“) the measurement can be started. To store the current measured height picture (with predefined name) the button **Save** has to be clicked after the measurement is finished. The name saved will then be displayed in the upper blue window bar.

Click the button **Naming assistant** or the appropriate icon again to disable the naming assistant.

9. Evaluation of 3D Data

9.1. General

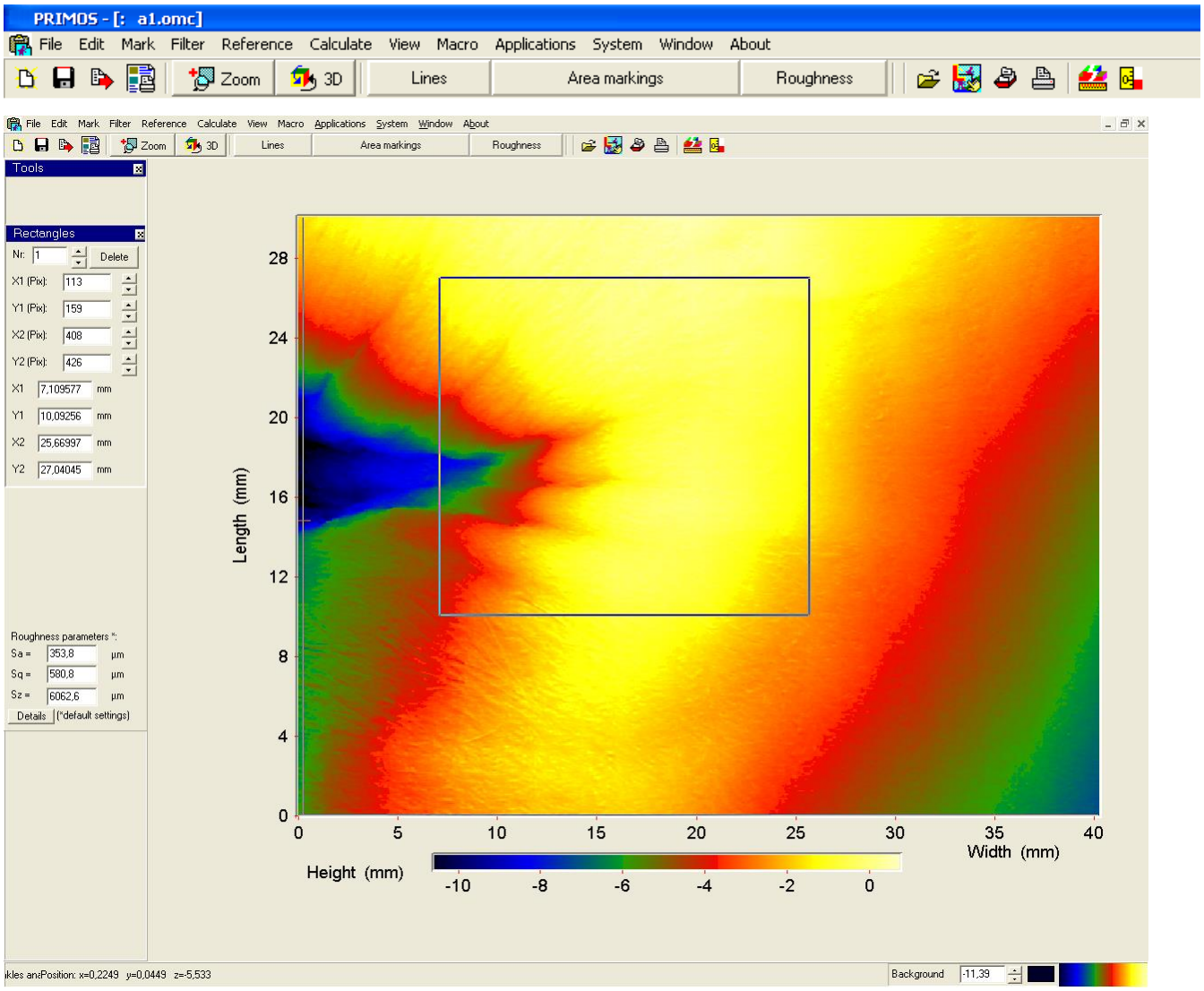
By opening a Fringe file (OMC or FD3 format) in the menu point **Applications | Open document** or clicking the icon , the topography processing program is started automatically. In the menu "Open document" it is now also possible to open more than one file at once. The function can be used by holding the “Ctrl” key and selecting all desired files by clicking on them with the left mouse button.



Img. 9.1: Opening multiple files

The evaluation of the measured data occurs with the help of this program. Following, the functions available in the menus of the topography processing program are described. (see also, chapter 20 “Brief description of the program functions in the measuring, control and evaluation software – Toolbar”).

The toolbar in the evaluation window has been given a new and simple design. The icons are sorted by functions and assembled in a well described context. In the context **Line markings,** there are all necessary tools for drawing single, multiple or free hand lines. The context menu, **Area markings** is for marking geometrical figures. The tools to calculate star and surface roughness are included in the context menu **Roughness** (s. Fig. below).



Img. 9.2 User interface of the topographical evaluation program

9.2. Functions in the menu “File“

Button	**Function**
Save as	Storing a measuring file = Click on button or icon; Enter file name; select file format and folder; click “save”
Export	Exporting a height picture to a ASCII, TXT or graphics file = click on button or icon; enter file name; Select file format and folder for saving; click “save”
Copy to print folder	Copy the currently displayed picture to the clipboard for the following insertion in a print folder document.
Close	Close the active window.

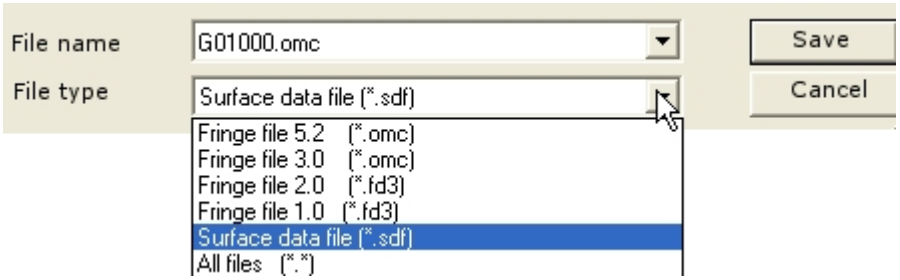
9.2.1. Saving of height picture parts with specified cropping parameters°

For some applications it makes sense to use only parts of a height picture, for example in the case of height pictures with invalid areas which could have a negative influence on the data evaluation. To save parts of height pictures proceed as follows:

→ Open the height picture or generate one through measurement

→ Zoom in on the required part of the height image:
Zoom in on the required area of height picture so that, e.g. the invalid areas do not appear in the cut out (menu **Edit | Zoom** or icon).

→ Save cut out of height picture:
In the window select, "Save" the file type "Surface Data File (*.sdf)". (menu **File | Save as...**).



→ Selection of file type in saving popup

→ enter a file name and click **OK**. The settings popup for "Surface Data File" opens (Fig. 9.4).

The following setting parameters are important:

File type

Make sure that "Signed Short" is always selected.

Range

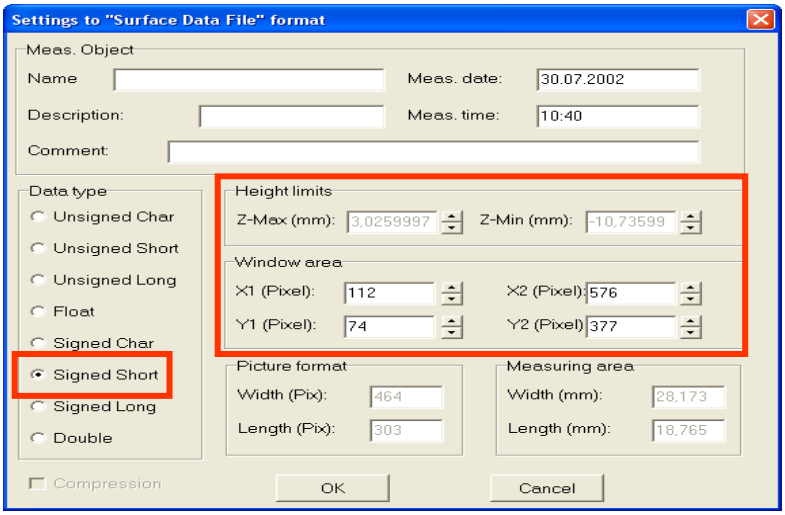
Here, the position and dimensions of the picture extract can be defined using pixel co-ordinates. As standard values, the current coordinates of the picture extract are always set. You can change these pixel values manually to define the picture part more precisely.

Height limits

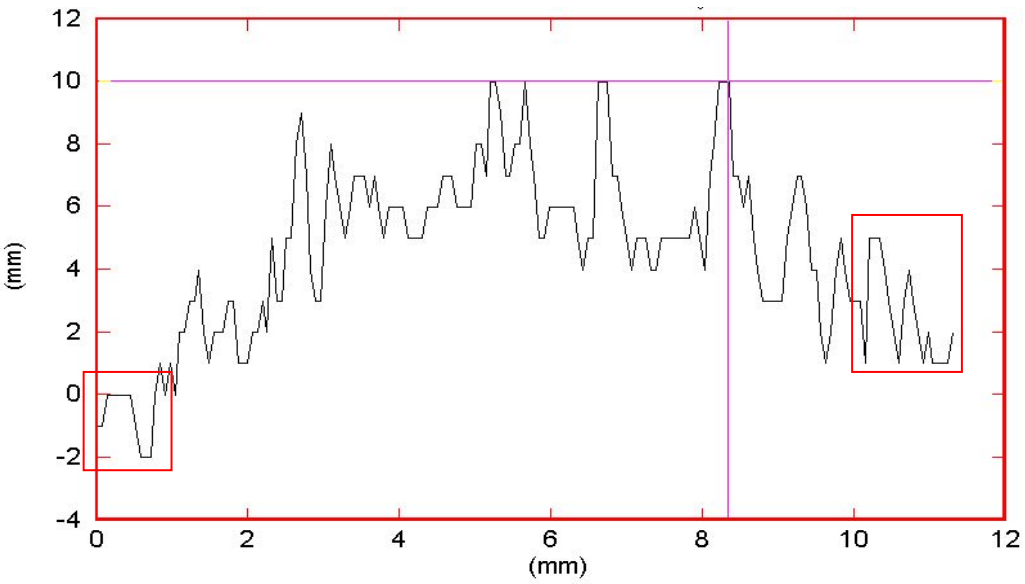
Here the height range is set. Take into account that, all height values of the pixels located in the picture part must be contained within this range.

Attention !

If the height range is selected to small, all larger height values will be trimmed to the set limits (Z-Min, Z-Max), i.e. the original height values will be lost and flattened areas will be generated in the height image (s. Fig. 9.5).



Img. 9.4 “Surface Data File“ – Setting popup



Img. 9.5 Flattened areas (because of the small selected height limits)

To open an SDF file, select **Applications | Open document** and select “Surface Data File (*.sdf)” as file type.

9.3. Functions in the menu “Edit“°

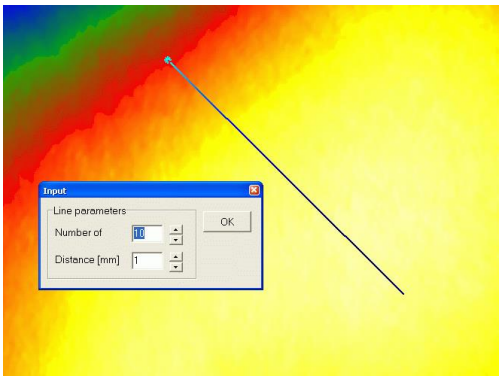
Button	Function
Undo	The last step to be carried out (filtering, alignment, etc.) is undone.
Zoom	Zoom function for the height picture. By means of the mouse, a rectangle can be drawn in the measuring area which will be enlarged and displayed. = click on button or icon; position cursor on the left top corner of the area which is to be enlarged; left click and hold mouse button; pull cursor to the bottom right corner of the area which is to be enlarged; release mouse button. To undo selection, right click anywhere in the height picture.
Crop zoom selection	Crops the selected area of the height picture, which can be saved
Cut	Cuts out a previously selected area of the height picture.
Cut-off	Cuts out an un marked area of the height picture.
Crop rectangle	Crops a cut out area of the height picture, which can be saved
Copy parameter	Copies parameters of a marked area in the height picture (e.g. lines, rectangles, etc.) into the clip board.
Insert parameter	Inserts a marked area from the clip board into the height picture.
Open parameter	Inserts a marked area from a marking file into the height picture.
Save parameter	Stores the parameters of a marked area in the height picture in a marking file.
Inverse picture	Inverts the height picture (calculation of the height picture print).
Flip vertical	Mirrors the height picture vertically.
Flip horizontal	Mirrors the height picture horizontally.
Turn 90° left	Rotates the height picture 90° left.
Turn 90° right	Rotates the height picture 90° right.
Turn180°	Rotates the height picture 180°.

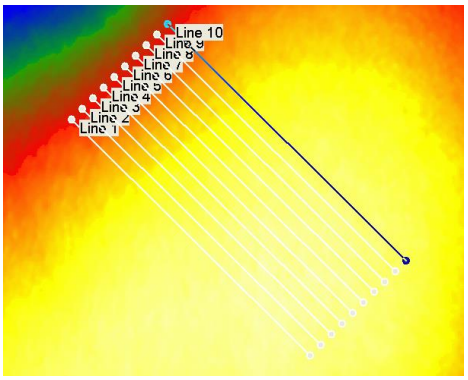
Turn free	Rotates the height picture to a freely selectable angle.
New scale	Changes the scaling of the height picture. Click icon; choose scaling factors (x,y,z) and height-plane of reference (z) for the change of scale of the height picture
New height resolution	Changes the height resolution of the height picture.

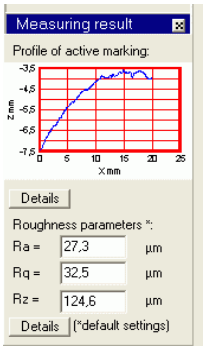
9.4. Functions in the menu “Mark“

There are three different buttons in the context menu "Marking Lines", which are used to draw one or multiple lines. When the mark multiple lines button is selected, one line must first be drawn on the height picture and after that a popup opens, in which number of lines and the distance between them must be entered.

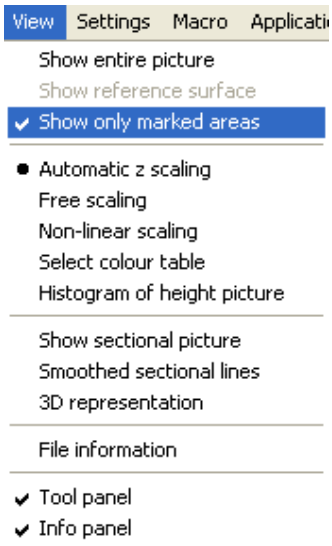
As another new function in the program, the roughness parameters for Ra, Rz and Rq as well as a minimized chart can be found at the bottom left side of the window. The chart and the roughness parameters results can be evaluated in more detail by pressing on the buttons "**Details**" (s. fig. below)

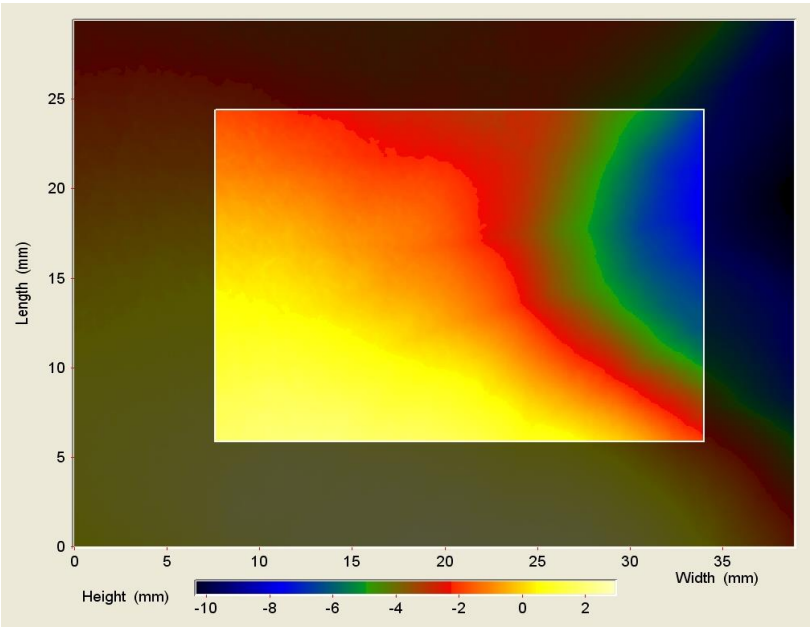


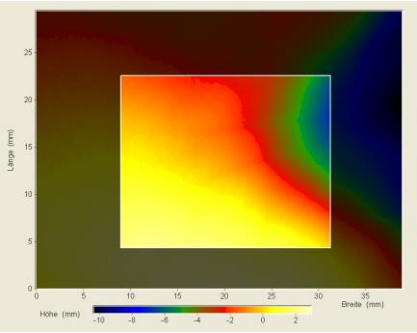


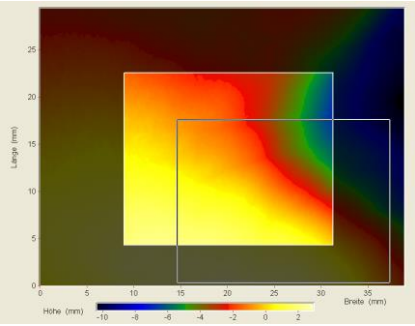


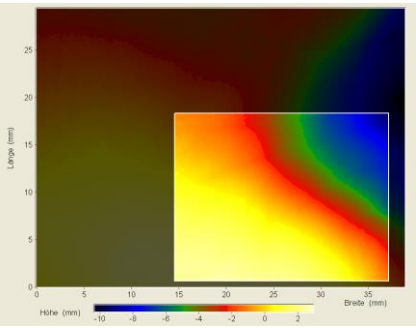
If **View | Show only marked areas** is selected, the unmarked areas are shaded darker. This way, the whole image is still visible but the marked and unmarked areas are easily distinguishable. (view image below)





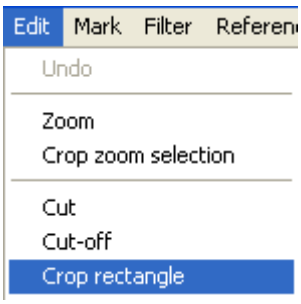


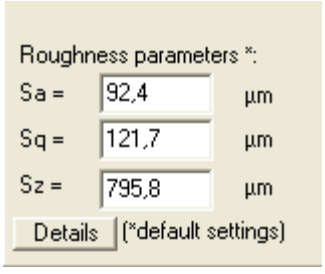




Unlike in the previous version of the PRIMOS software, the marked areas can now easily be cropped and saved in the *.OMC- format.

Three parameters **Sa**; **Sz**; and **Sq** of the roughness evaluation results are shown at the left, bottom side of the window when a rectangle is drawn on the height picture.

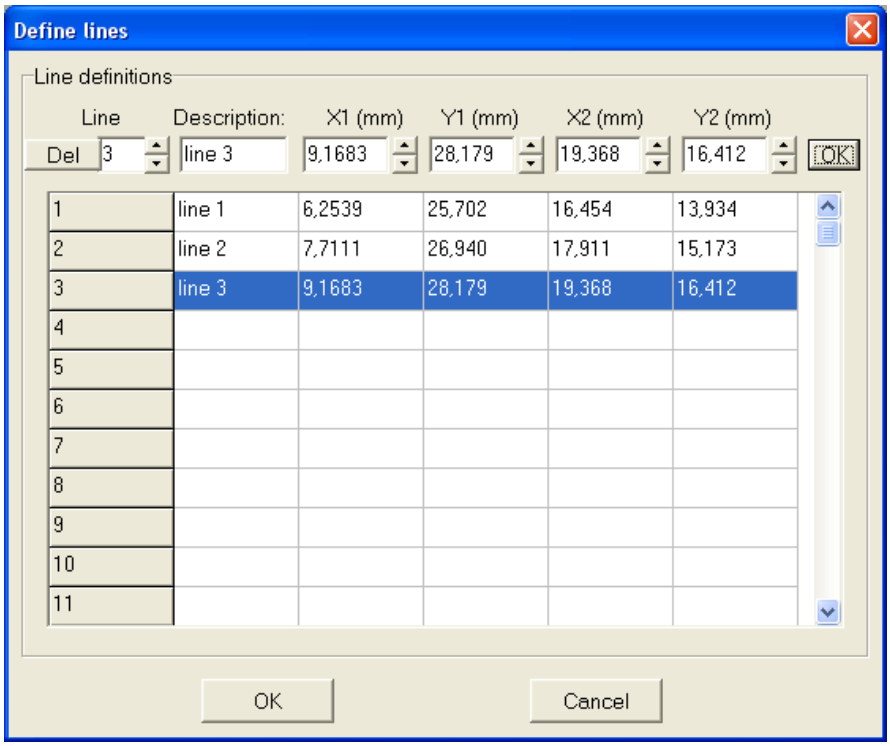




Button	Function
Reset markings	Deletes all markings on the measured surface = Click button or icon
Line markings	
Draw lines	Marking a line in the height picture. Position the cursor in the height picture at the starting point of the line to be drawn; click the left mouse button; hold it and move the cursor to the point at which the line is to end; release the left mouse button.
Draw N parallel Lines	Draws multiple lines on the height picture
Draw freehand line	draw a freehand line in the height picture. Position the cursor in the height picture at the starting point of where the freehand line is to be drawn; click the left mouse button; move the cursor to the next corner of the freehand line; click the left mouse button, etc. ; after clicking the left mouse button for the last corner of the freehand line click the right mouse button (the first and the last corner will not be connected).

Button	Function
Area markings	
Draw circle	Mark a circle in the height picture. Position the cursor in the height picture at a point of the circle line which is to be drawn; click the left mouse button; hold it and move the cursor in the height picture; when the circle has the desired dimensions and position, release the left mouse button.
Draw ellipse	Mark an ellipse in the height picture. Position the cursor in the height picture at a point of the ellipse curve which is to be drawn; click the left mouse button; hold it and move the cursor in the height picture; when the ellipse has the desired dimensions and position, release the left mouse button.

Draw rectangle	Mark a rectangle in the height picture. Position the cursor in the height picture at the point (an edge) at which you wish the polygon to start; click the left mouse button; hold it and move the cursor in the height picture; when the rectangle has the desired dimensions and position, release the left mouse button.
Draw polygon	Mark a polygon line in the height picture. Position the cursor in the height picture at the point at which you wish the polygon to start; click the left mouse button; move the cursor to the next corner of polygon; click the left mouse button, etc. ; after clicking the left mouse button for the last corner of polygon click the right mouse button – the program automatically connects the first and the last corner of polygon. The polygon line is very qualified if a part of the height picture should be cut out.
Define background depth	Change the background depth, i.e. the background colour of the height picture. Position the cursor at a point in the height picture which has the desired colour for the background; click the right mouse button; in the case that parts of the height image are cut out at any point in time, these spaces will be filled with the selected colour.
Define line	Setting of lines with defined positions in the height picture by means of an input window (s. Fig. 9.6). The coordinates of already existing lines will be indicated. By means of the scrolling buttons of the field “Line“ the number of the line which is to be worked on can be selected. After this, enter or change the description and the coordinates of the line. By clicking the **OK** button the line will be added to the list. By means of the button **Del** a selected line will be deleted from the list.



Img. 9.6 Define lines

9.5. Functions in the menu “Filter“

Button	Function
Align	aligns the height picture to its averaged plane or a plane defined by selected area.
Filter from inverse marking	Filtering the area outside the selection
Polynomial-filter	Removes the deviation from geometric forms in height images corresponding to the selected class of polynomial.
Remove invalid	Assigning of an adjacent height value in case of the absence of own height value for the measuring point.
Remove hairs	Elimination of hairs from the measuring data of a skin surface.
Gaussian filter	Apply a Gaussian filter to the height picture.
Median filter	Apply a median filter to the height picture.
Average filter	Apply an average filter to the height picture.
Robust high-pass filter	Apply a robust polynomial filter to the height picture.

Generally each filtering is connected with a loss of information. Nevertheless in many cases it is useful to filter the data. Depending on the kind of measuring tasks, results can be improved in this way or an evaluation becomes possible only through filtering.

Objective	**Filter**
Elimination of shadowed areas	Remove invalid values
Elimination of “point” errors	Median filter
Reduction of system noise	Average filter, Gaussian filter
Separation of micro- and macro structure	Polynomial-filter
Separation of fine skin structure	Robust high-pass filter
Determination or filtering of waviness of skin structure	Fourier Filter

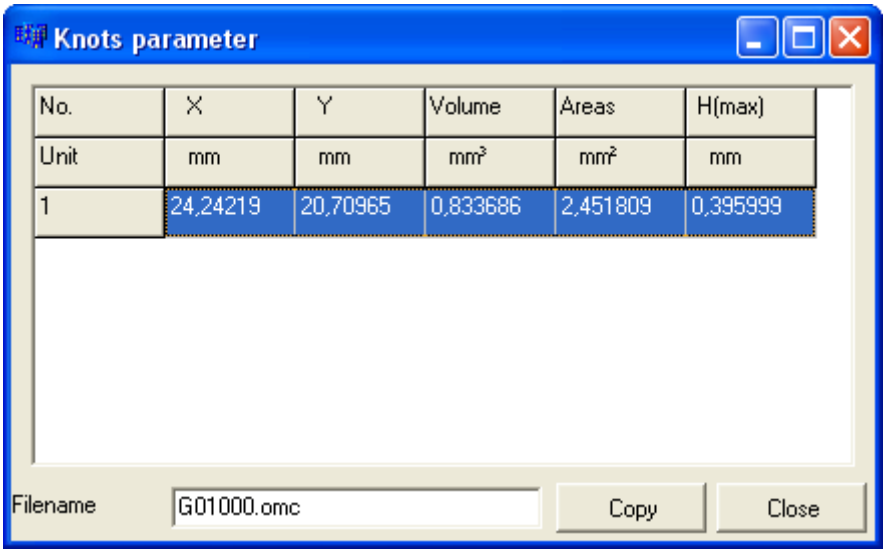
Select the filter size or degree of the polynomial only as big as necessary. For comparative measurements of samples it is necessary to always use the same filter (same filter settings). Filtering can be simplified if the automatic evaluation available in the database mode is used.

9.6. Functions in the menu “Reference“

Button	**Function**
Define as reference	The open (active) height picture will be defined as the reference measurement.
Open reference	Open a measuring file to define its contained height picture as reference measurement. Click button; choose file, file format and file name; click “open”
Meas. data + Reference	Opening a second measuring file after opening a measuring file to use as reference measurement or appointing an already opened file as reference measurement; By selecting a menu point the corresponding mathematical operation will be performed with the height pictures.
Meas. data - Reference	
Reference - Meas. data	
Meas. data * Reference	
Meas. Data / Reference	

9.7. Functions in the menu “Calculate”

Button	Function
Wrinkle analysis (optional)	Automatic detection of wrinkles. Classification and calculation of volume, depth, area, form factor, total length and number of wrinkles.
Surface size even	Calculation of the “stretched” area of the (height picture) surface or parts of the surface that were previously marked the height picture.
Surface size curved	Calculation of the area includes the waviness of the whole height picture or the marked area = click button
Surface minimum, maximum	Determination of the height value of the highest and the lowest measuring point of the 3D picture or its part marked before.
Determine knot parameters	Automatic detection of lumps on the 3D skin surface. The lump parameters will be shown in a table window (s. Fig.9.7). The parameters are: - x, y = position of lump - volume, area = volume and area of lump - H(max) = highest point of lump By use of the button **Copy,** the table can be copied via the clipboard to other programs and the data can then be processed further with these programs. If a line is marked, only this line will be copied. The function is only qualified for lumps that are small in comparison to the measuring area.
Volume of cavities	Volume calculation of the height profile (or a marked part of it) below a reference plane.
Volume of risings	Volume calculation of the height profile (or a marked part of it) above a reference plane.
Offset to reference plane	Define new measuring reference plane or height for the further volume calculation. The plane is re-determined and is included in the calculation as a new plane.



Img. 9.7 Knots parameters

9.8. Functions in the menu “Group evaluation“

After marking of an area in the measurement data, the surface size will be shown for the flat and cambered area. The results of star roughness now also include the standard deviation of the measuring data, which can be useful to get information about the isotropy of skin.

An export function for MS Excel is added to the new software version, which can be used to export the results in **CVS**- Excel format.

Button	**Function**
Line roughness	Opening of the dialogue window for the calculation of line roughness parameters.
Star roughness	Opening of the dialogue window for the calculation of star roughness parameters.
Area roughness	Opening of the dialogue window that calculates the area roughness parameter
Stop evaluation	Stop calculation of roughness parameters for previously selected height pictures and type of roughness

Start elastic matching	Perform elastic matching for previously grouped files

More information on roughness parameters is available in chapter 10 “Roughness parameters”.

9.9. Functions in the menu “View“

Button	**Function**
Show entire picture	Displays entire height picture (Default-view)
Show reference surface	Displays the defined reference surface of height picture
Show only marked Areas	Displays only the marked area of height picture
Auto. Z-Scaling	Automatic height scaling – uniform colour dispersion between the highest and lowest points (Default scaling mode)
Free Scaling	Free height scaling – the possibility to highlight any small area .it is possible to enter the minimal and the maximal Z-values in the selected areas in the popup.
Non linear Scaling	Possibility of specially highlighting interesting height ranges. The available colours of the colour panel can be distributed non-linearly within the entire height range. Click on button; in the histogram that opens, click one of the red dots (with left mouse button, dot turns green); Move cursor onto blue histogram line; hold down left mouse button and move mouse – non-linear red histogram line appears, i.e. scaling is non linear.
Colour coding	Possibility of visualising some surface defects by dividing the height profile through two intersecting lines. = Click button – a window opens which contains a scroll bar for adjusting the two leveings - The resulting 3 height ranges are represented by different colours.

Histogram of height picture	Displays the frequency distribution of the height values in the height picture = click button – a histogram window containing the frequency distribution of the height values; the number of classes for the calculation of the frequency distribution and the displayed height area can be entered; by positioning the cursor in the histogram, the data of the related class is shown in the right side of the window.
Show sectional picture	Displays a graphic profile representation (2D profile) of the marked line(s), circle(s), rectangle(s), etc.. in the height picture
Smoothed sectional lines	Displays an approximated graphic profile representation (2D profile) of the line(s) marked in the height picture.
3D representation	Displays a 3D representation of the colour coded height picture (see chapter “3D representation”).
File information	Displays information stored in the measuring file additional to height values, e.g. description of the measuring object.
Tools panel	Display / shield the toolbar.
Info-panel	Display / shield the information line.

9.10. Functions in the menu “Settings”

Button	**Function**
Select colour table	Set colour scale for height picture = click button or icon – the window for choosing the colour scaling of the height image opens; choose desired colour scaling with click of the left mouse button and confirm the selection with “OK”
Select font	Selecting text font for graphic representation and print-out of the measuring results= click button or icon – the window for selecting font type etc. opens; left click on desired font type and confirm selection with “OK”

9.11. The Menu “Macro“

Button	Function
Start recording	Start the macros recording
Stop recording	Stop the macros recording

For more information about the macro function see chapter 11 “Macro Function”.

9.12. The Menu “Applications“

Button	Function
Open document	Opening of a stored measuring file and running the topography evaluation program for its further evaluation
Open print folder	Opens the print folder for design and print-out of evaluated measuring data
Open database	Open the database window of the PRIMOS software
Take up height picture into work area	Transfer of 3D measuring data from the measuring program to the topography evaluation program for its further evaluation
3D Matching elastic surface	Open the program window for 3D matching of measured skin areas
Activate external trigger	Activate the trigger on the measurement instrument
Setting...	Control setting for the trigger
About trigger...	Information about the trigger
Start Measuring program	Opens measuring program window
Start calibration program	Opens calibration program window
Quit	Quit the program PRIMOS

Further information on how to use the above mentioned functions are also included in the chapter 20 “Brief description of the program functions in the measuring, control and evaluation software – Toolbar”.

10. Roughness parameters

10.1. General

The standard deviation of measured results of star roughness are now automatically calculated and included, which can provide useful information about the isotropy of skin.

An export function for MS Excel has been added to the new software version, which can be used to export the results in **CVS**- Excel format.

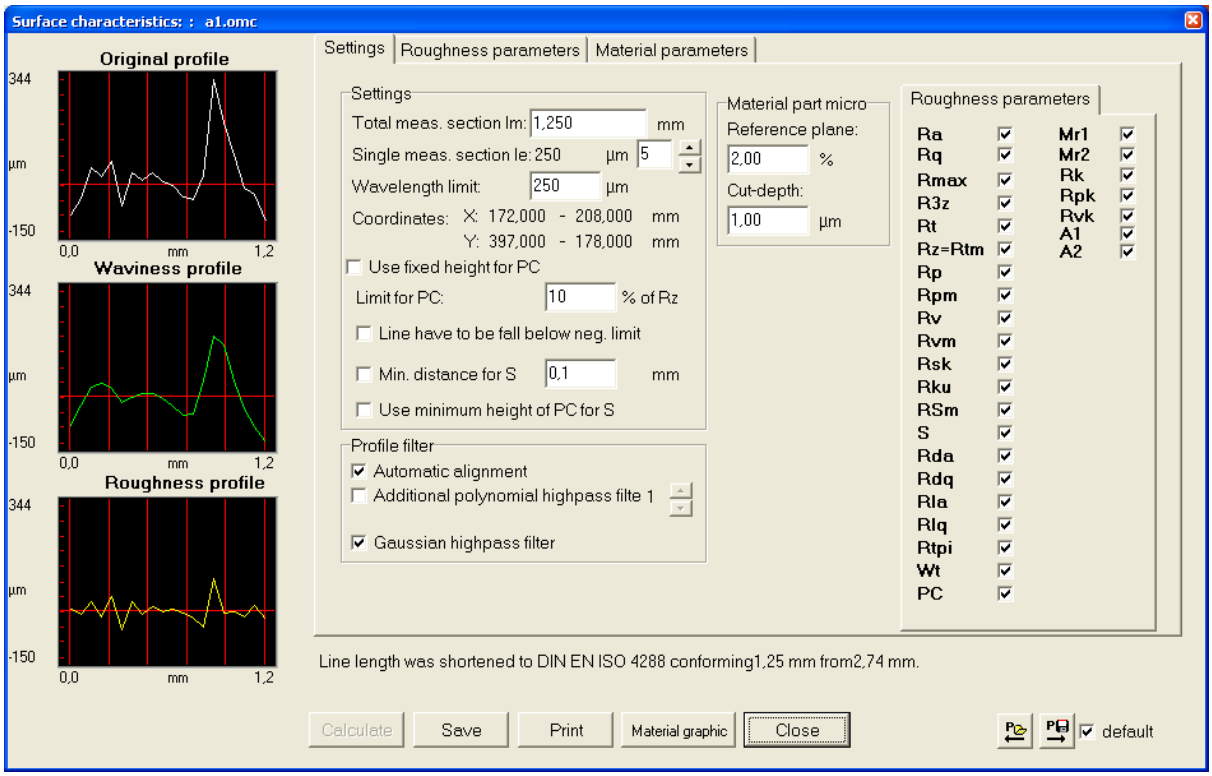
For the calculation of correct roughness parameters, a measuring field has to be selected which, concerning the lateral and vertical resolution is suitable to reproduce the profile of the existing microstructure accurately.
The calculation of the line roughness parameters is performed in compliance with the appropriate DIN standards.
To receive realistic values, select the total line length and the cut off frequency according to the corresponding DIN standard if possible.
By using the polynomial filtering (the degree of the polynomial can be changed) it is possible to remove long wavy parts of the surface profile.
If necessary, cut off (wave) filters and Gaussian filters can be applied several times to the same set of data.
The calculation of star roughness is used to determine the dependency between the direction (angle) of the profile lines on the surface and the roughness parameters. Generally, roughness parameters should be determined in the direction of the largest height differences.
Area roughness parameters have so far not been standardised. They use a significantly larger amount of information than line roughness parameters. Small deviations in the surface can be detected much better by use of these parameters.

10.2. Line roughness

For the calculation of the line roughness, draw one or more lines (using the edit tool

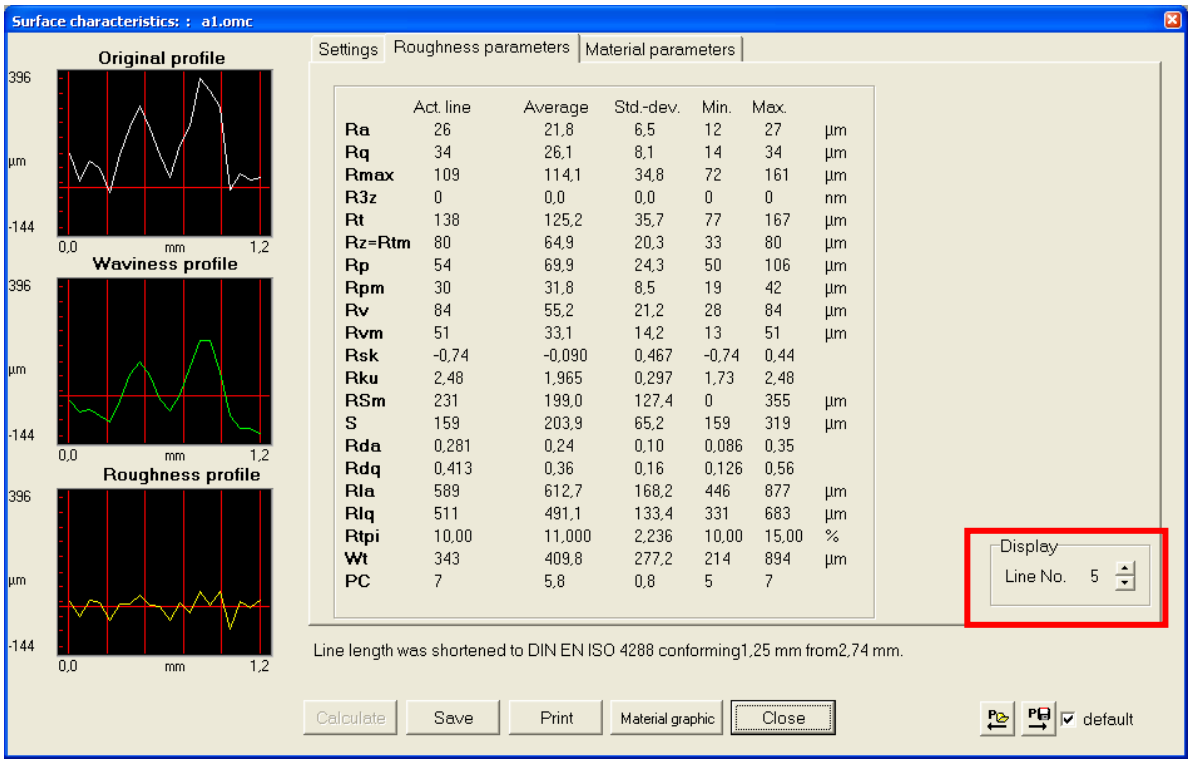
) into the colour coded height picture. By use of the menu **Mark | Define line** it is possible to obtain a defined start and finishing point for any line. Position and length of the profile cut lines can be stored (menu **Edit | Save parameter**) and profile cut lines of the same length can be inserted in other height pictures at the same position (menu **Edit | Open parameter**). This allows the determination of roughness parameters for different height pictures

under equal conditions. Display the profile line by clicking the icon Details or the button **View | Show sectional lines.** If more than one line was drawn, select the line for which the roughness calculation should be performed with the scrolling buttons in the status bar down on the right. Start the calculation of the roughness parameters by clicking the icon Details. In the window (see Fig. 10.1) which opens, selected roughness parameters (right in the window) as well as the settings (position and length of measuring line, filter adjustments – see table below) used for their calculation are displayed.



Img. 10.1: Line roughness

At the evaluation of several parallel lines of equal length, the roughness of all lines is calculated together. The result of each line can be shown on the respective tab (see figure 10.2).


Surface characteristics: : a1.omc
Original profile
Waviness profile
Roughness profile
396
µm
-144
0,0
mm
1,2
Settings
Roughness parameters
Material parameters
Act. line Average Std.-dev. Min. Max.
Ra 26 21,8 6,5 12 27 µm
Rq 34 26,1 8,1 14 34 µm
Rmax 109 114,1 34,8 72 161 µm
R3z 0 0,0 0,0 0 0 nm
Rt 138 125,2 35,7 77 167 µm
Rz=Rtm 80 64,9 20,3 33 80 µm
Rp 54 69,9 24,3 50 106 µm
Rpm 30 31,8 8,5 19 42 µm
Rv 84 55,2 21,2 28 84 µm
Rvm 51 33,1 14,2 13 51 µm
Rsk -0,74 -0,090 0,467 -0,74 0,44
Rku 2,48 1,965 0,297 1,73 2,48
RSm 231 199,0 127,4 0 355 µm
S 159 203,9 65,2 159 319 µm
Rda 0,281 0,24 0,10 0,086 0,35
Rdq 0,413 0,36 0,16 0,126 0,56
Rla 589 612,7 168,2 446 877 µm
Rlq 511 491,1 133,4 331 683 µm
Rtpi 10,00 11,000 2,236 10,00 15,00 %
Wt 343 409,8 277,2 214 894 µm
PC 7 5,8 0,8 5 7
Display
Line No. 5
Line length was shortened to DIN EN ISO 4288 conforming1,25 mm from2,74 mm.
Calculate
Save
Print
Material graphic
Close
default

Img. 10.2 Roughness parameters

If the settings were changed, the calculation of roughness parameters has to be refreshed by clicking the button **Calculate**. Further more, in the left part of window the roughness and waviness profile along the profile line as well as the material bearing curve are indicated. The position of the reference line for the indicated material portion can be changed under “reference plane”. The button “**Material graphic**” serves for the display of the material portion curve, the void area curve and the material area curve. By moving the mouse cursor in the diagrams of the above mentioned characteristics, their parameters will be indicated for different positions of the reference line. By clicking the **Save** button in the main roughness window, a window for storage of roughness parameters and/ or material characteristics in a text file opens By clicking the **Print** button, the roughness parameters and/ or the material characteristics will be printed. By means of the button “**Material graphic**”, the window for the display of material profiles can be opened. The window “Line roughness” will be closed by clicking the **Close** button.

Description of the window elements:

Name of Elements	Description
Original profile	Displays the original profile. Compared to the intersecting line image, a height offset value was added, that sets the middle value of the whole profile to 0. Through this, a clear depiction is reached as all 3 profiles exhibit the same scaling.
Waviness profile	Displays the determined waviness profile.
Roughness profile	Displays the determined roughness profile.
Total meas. section	Displays the total length of the profile and can be changed. When starting the line roughness dialogue, the length of the profile is set to the next smallest, recommended measuring path value, which are conducted in the DIN EN ISO 4228. Further information regarding the choice of path length can be found further down.
Single meas. section	Displays the length of a single measuring distance which can be changed. It can only be a whole numbered part of the full measuring distance. When starting the line roughness parameter, the single length is only one fifth of the full length.
Wavelength limit	Displays the wavelength limit, which can be changed. When starting the line roughness dialogue, the wave length is one fifth of the length of the entire measuring distance and is so the same length as the single meas. Section.
Coordinates	Displays the coordinates of the height picture.
Use fixed height for PC	When this switch is not activated, then for the calculation of peak heights, only heights which are above a proportion of calculated Rz-values, which must be set, are included. In the case that it is activated, only one fixed height will be taken into account.

Name of Elements	Description
Line have to be fall below neg. limit	When this switch is activated, then for the determination of the number of peaks after the counting of the first peak, the next are only counted when the roughness profile falls under the negative height value for which one peak was counted. If the switch is off, then the next peak can be counted when the roughness profile falls under the height threshold.
Min. distance for S	For the distance between peaks, The minimum distance is defined for the distance between the peaks
Use minimum height of PC for S	Only the higher peaks will be included in the calculation of minimum distance.
Automatic Alignment	When this menu item is activated, then before the roughness calculation, a polynomial of the 1st degree is subtracted from the original profile. This switch is on by default.
Additional Polynomial-High pass filter	If this switch is activated, then before the roughness calculation, a polynomial of the 2-8th degree is subtracted from the original profile cut. This filter removes waviness from the profile even more.
Gaussian High pass filter	This filter separates the waviness from the roughness. It is set at DIN EN ISO 11562. It is switched on at default.
Reference plane	This value defines the reference plane for the parameter Rtpi. See further below for more information on this.
Cut-depth	This value defines the cut-depth for the parameter Rtpi. See below for more information on this.
Calculate	Calculate with the current settings.
Save	Save the result.
Print	Prints the result
Material Graphic	Displays the material graphical representation
Close	Closes the window.

Line roughness characteristics displayed in the right of the window are:

Name	**Abbreviation**	**Description**
Average roughness	Ra	Ra is the average of the absolute values of the profile heights of the roughness profile. Ra is a vertical parameter, that is, it describes the roughness in a vertical direction. $Ra = \frac{1}{lr} * \int_0^{lr} \lvert R(x) \rvert dx$
Root mean square roughness	Rq	Rq is the root mean square average of the profile heights of the roughness profile. Rq is a vertical parameter, that is, it describes the roughness in a vertical direction. $Rq = \sqrt{\frac{1}{lr} * \int_0^{lr} R^2(x) dx}$
Maximum roughness depth	Rmax	Rmax is the largest height difference in a single measurement section (see Rz). Rmax is a vertical parameter, that is, it describes the roughness in a vertical direction.
Base roughness depth	R3z	R3z is the average of the single base roughness depths. The single base roughness depth is the difference from the third highest profile peak to the third deepest profile valley within an single measurement section. If there are no 3 peaks or valleys in one of the single measurement section, this parameter is set to 0. R3z is a vertical parameter, that is, it describes the roughness in a vertical direction.
Maximum height of the roughness profile	Rt	Rt is the height difference from the highest peak to the deepest valley within the total measurement section. Rt is a vertical parameter.
Average maximum height of the roughness	Rz=Rtm	Rz is the average of the single roughness depths. The single roughness depth is the difference from the highest profile peak to the deepest profile valley within an single measurement section. Rz is a vertical parameter, that is, it describes the roughness in a vertical direction.
Height of the largest profile peak	Rp	Rp is the height of the largest profile peak within the total measurement section. Rp is a vertical parameter.

Average height of the largest profile peaks	Rpm	Rpm is the average of the highest profile peaks within the single measurement sections. Rpm is a vertical parameter, that is, it describes the roughness in a vertical direction.
Depth of the largest profile valley	Rv	Rv is the depth of the largest profile valley within the total measurement distance. Rv is a vertical parameter.
Average depth of the profile valleys	Rvm	Rvm is the arithmetic average of the deepest profile valley within an individual measurement distance across all individual measurement distances. Rvm is a vertical parameter, that is, it describes the roughness in a vertical direction.
Skewness	Rsk	Rsk is a measure of the asymmetry of the amplitude density curve. Negative skewness indicates a surface with load bearing behavior. For normally distributed profile parameters, Rsk = 0. Rsk is a vertical parameter, that is, it describes the roughness in a vertical direction. $Rsk = \frac{1}{Rq^3} * \left[\frac{1}{lr} * \int_0^{lr} \left| R^3(x) \right| dx \right]$
Kurtosis	Rku	Rku is a measure of the steepness of the amplitude density curve. For normally distributed profile parameters, Rku = 3. Steeper roughness profiles have higher values. Rku is a vertical parameter, that is, it describes the roughness in a vertical direction. $Rku = \frac{1}{Rq^4} * \left[\frac{1}{lr} * \int_0^{lr} \left| R^4(x) \right| dx \right]$
Average spacing of the roughness profile elements	RSm	RSm is the average distance between the profile elements Xs. The following counting thresholds are used for the calculation of RSm: in the vertical direction, 10% of Rz and in the horizontal direction, 1% of the total measurement section. RSm is a horizontal parameter, that is, it describes the roughness in the horizontal direction. $RSm = \frac{1}{n} * \sum_{i=1}^{n} Xs_i$
Average peak distance	S	S states the central distance of the profile peaks in the roughness profile. Unless otherwise shown in the settings,

		the minimum height for a peak is the parameter 0. In the settings, a counting threshold in the horizontal direction can also be defined. S is a horizontal parameter.
Average slope of the roughness profile	Rda	Rda is the arithmetic average of the local profile slopes. Rda is a mixed parameter, that is, it describes the roughness in the vertical and horizontal directions. $Rda = \left\lvert \frac{dr}{dx} \right\rvert dx$
Root mean square slope of the roughness profile	Rdq	Rdq is the root mean square value of the local profile slopes. Rdq is a mixed parameter, that is, it describes the roughness in the vertical and horizontal directions. $Rdq = \sqrt{\left(\frac{dr}{dx}\right)^2 dx}$
	Rla	Rla is derived from Rda and is calculated from the below named formula. $Rla = 2 * \pi * \left(\frac{Ra}{Rda}\right)$
	Rlq	Rlq is derived from Rdq and is calculated from the below named formula. $Rlq = 2 * \pi * \left(\frac{Rq}{Rdq}\right)$
Material part micro	Rtpi	The settings of **reference plane** and **cut-depth** are intended for this parameter. It is obtained from the roughness profile. The reference plane defines the sectional plane at which the section is started. If the reference plane is 5 %, then the height of this plane is at a bearing part ratio of 5 %. The cut-depth sets the evaluation section plane below the reference planeby the stated amount. The material part micro is then the ratio of the material part to the entire length. This parameter is stated in percent. For instance, if the cut-depth is set to 0, Rtpi will have the value of the reference plane (except for rounding errors within point resolution (for instance, when the profile has only 100 points, the results will be precise to 1 percent).
Maximum height of waviness profile	Wt	Wt is the difference between the height of the largest profile peak and the depth of the largest profile valley from the waviness profile.

Peak number	PC	PC is the number of peaks in the total measurement distance. There are 2 setting values for this parameter, which are listed under the description of the window elements farther up in the text.
Bearing part Mr1	Mr1	Mr1 is the bearing part in percent which separates the protruding peaks from the core roughness profile. This parameter and the 6 following ones are determined from a roughness profile which is determined in accordance with the filter process described in DIN EN ISO 13565-1. This filter process is used to suppress grooves. More information about the calculation of this and the 6 following parameters is described farther below.
Bearing part Mr2	Mr2	Mr2 is the bearing part in percent which separates the deep valleys from the core roughness profile.
Core roughness depth	Rk	Rk is the depth of the core roughness profile.
Reduced peak height	Rpk	Rpk is the average height of the protruding peaks above the protruding core roughness profile.
Reduced valley depth	Rvk	Rvk is the average depth of the profile valleys below the core roughness profile.
Material filled peak area	A1	A1 is calculated using the formula shown below. According to the below shown formula, there is not yet a resultant area – in order to obtain the area, the calculated parameter must be multiplied by the total measurement section. $A1 = \frac{1}{2} * Rpk * Mr1$
Empty valley area	A2	A2 is calculated using the formula shown below. According to the below shown formula, there is not yet a resultant area – in order to obtain the area, the calculated parameter must be multiplied by the total measurement section. $A2 = \frac{1}{2} * Rvk * (100 - Mr2)$

Explanation of the utilized abbreviations:

lr = length of a single measurement section
R(x) = profile parameter of the roughness profile at position x
n = number of profile elements
Xs = width of a profile element
$\frac{dr}{dx}$ = local elevation of the roughness profile

More information about line roughness:

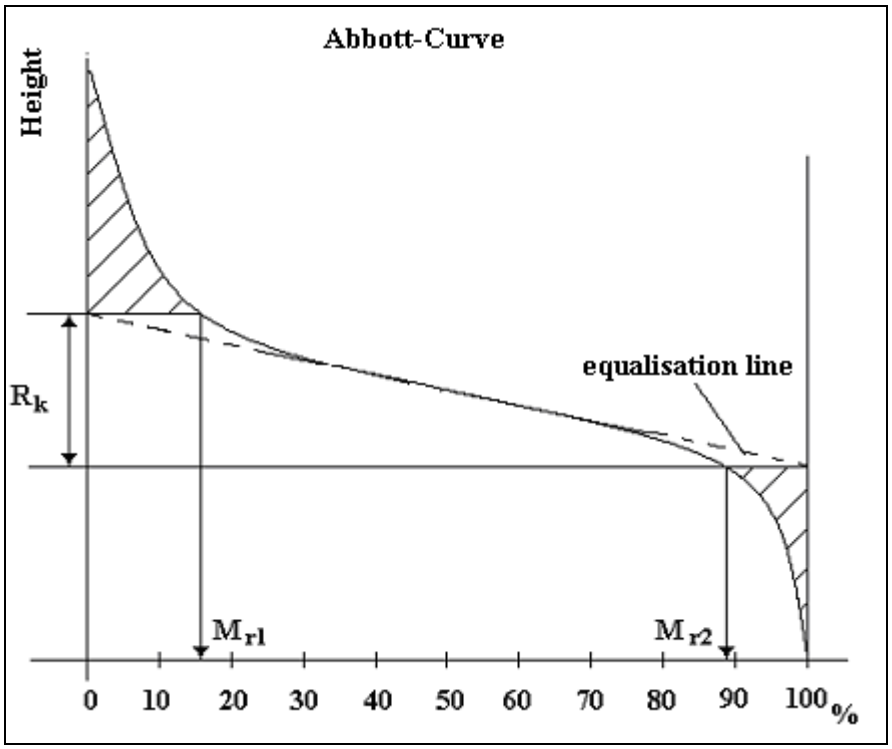
According to the norm DIN EN ISO 4288 (1998) the following wavelength limit, specific and total measuring lengths are recommended:

Periodic profile	**Non-periodic profile**		**Wavelength limit**	**Specific length**	**Total length**
RSm (mm)	Rz (µm)	Ra (µm)	λc (mm)	lr (mm)	ln (mm)
> 0,013 to 0,04	to 0,1	to 0,02	0,08	0,08	0,4
> 0,04 to 0,13	> 0,1 to 0,5	> 0,02 to 0,1	0,25	0,25	1,25
> 0,13 to 0,4	> 0,5 to 10	> 0,1 to 2	0,8	0,8	4
> 0,4 to 1,3	> 10 to 50	> 2 to 10	2,5	2,5	12,5
> 1,3 to 4	> 50 to 200	> 10 to 80	8	8	40

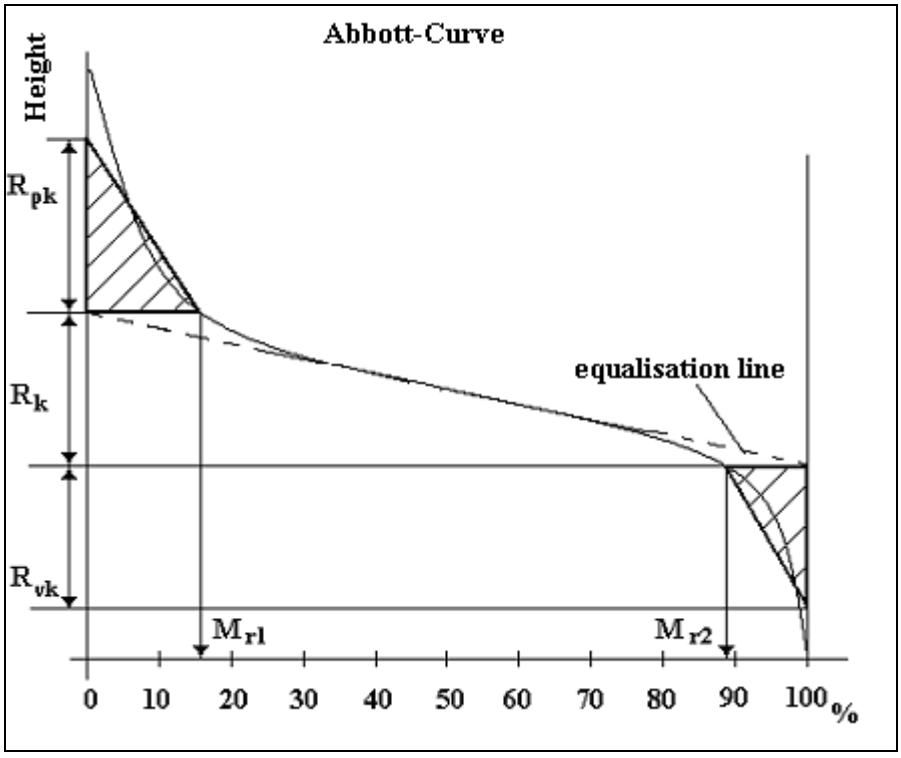
At the start of the calculation of the line roughness, the length of the line is set to the next smallest value, which is given in the table above in the column “Total length”. The line length will be reduced by this value at the beginning and the end.

If not given otherwise, the total measuring length should be divided into 5 individual measuring lengths because parameters which calculate over single measuring distances are estimated statistically more reliable this way.

The specific measuring length and the wavelength limit must have the same value for the estimation of line roughness.



Img. 10.3: Estimation of the material parameters Mr1, Mr2 und Rk



Img. 10.4: Estimation of the material parameters Rpk und Rvk

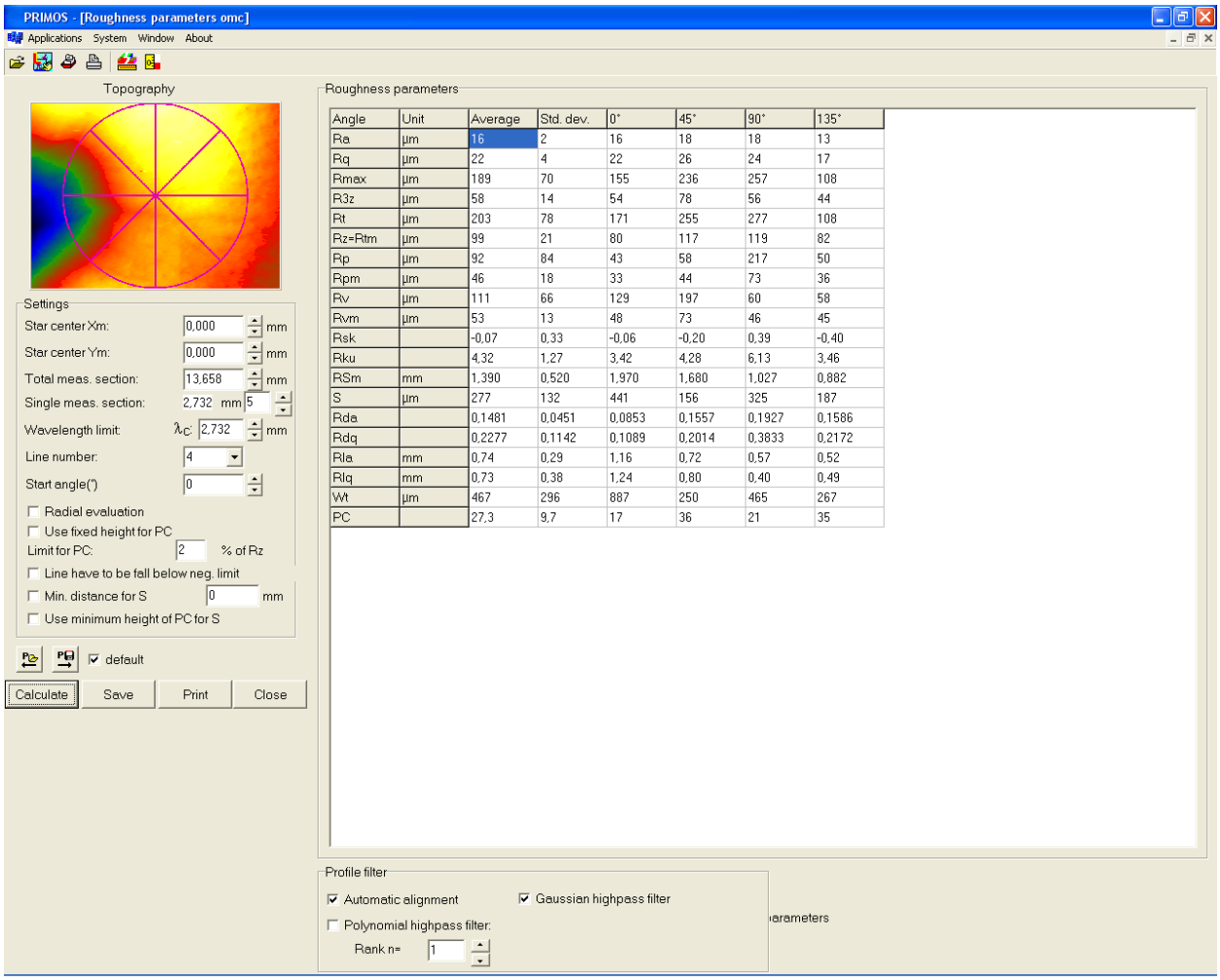
After a roughness calculation, the roughness and waviness profile along the intersecting line as well as the material bearing curve can be displayed by clicking the appropriate button Details of the intersecting line window.
On the two above figures, the material part curves are graphically displayed, which are also called Abbott curves.

10.3. Star roughness

For the calculation of the star roughness, the profile lines are arranged radically by the program. The calculation of the parameters is performed similarly to the calculation of the line roughness (separately for each astral arranged profile line). To open the window for star roughness calculations, select the menu item **Parameters | Star roughness** or click the icon Roughness. For adjustment of the position and number of intersecting lines, the parameters shown in the table below are available. By means of the appropriate scroll buttons these parameters can be changed.

Parameter	**Description**
Xm, Ym	Coordinates of the intersection point of the intersecting lines
lm	Total measuring length, length of profile cross section
le	Single measuring length (total measuring length consists of 5 single segments)
λc	border wavelength

Parameter	**Description**
Line number	Number of profile cross section
Starting angle	Starting angle for the placing of profile intersections
Radial evaluation	If this field is enabled, the profile cross sections start at the center of circle and end at the circle perimeter. If it is disabled the cross sections start and end at the circle perimeter and go through the center of circle (diameter).


PRIMOS - [Roughness parameters omc]
Applications System Window About
Topography
Roughness parameters
Angle Unit Average Std. dev. 0° 45° 90° 135°
Ra µm 16 2 16 18 18 13
Rq µm 22 4 22 26 24 17
Rmax µm 189 70 155 236 257 108
R3z µm 58 14 54 78 56 44
Rt µm 203 78 171 255 277 108
Rz=Rtm µm 99 21 80 117 119 82
Rp µm 92 84 43 58 217 50
Rpm µm 46 18 33 44 73 36
Rv µm 111 66 129 197 60 58
Rvm µm 53 13 48 73 46 45
Rsk -0,07 0,33 -0,06 -0,20 0,39 -0,40
Rku 4,32 1,27 3,42 4,28 6,13 3,46
RSm mm 1,390 0,520 1,970 1,680 1,027 0,882
S µm 277 132 441 156 325 187
Rda 0,1481 0,0451 0,0853 0,1557 0,1927 0,1586
Rdq 0,2277 0,1142 0,1089 0,2014 0,3833 0,2172
Rla mm 0,74 0,29 1,16 0,72 0,57 0,52
Rlq mm 0,73 0,38 1,24 0,80 0,40 0,49
Wt µm 467 296 887 250 465 267
PC 27,3 9,7 17 36 21 35
Settings
Star center Xm: 0,000 mm
Star center Ym: 0,000 mm
Total meas. section: 13,658 mm
Single meas. section: 2,732 mm 5
Wavelength limit: λc: 2,732 mm
Line number: 4
Start angle(°) 0
Radial evaluation
Use fixed height for PC
Limit for PC: 2 % of Rz
Line have to be fall below neg. limit
Min. distance for S 0 mm
Use minimum height of PC for S
default
Calculate Save Print Close
Profile filter
Automatic alignment
Gaussian highpass filter
Polynomial highpass filter:
Rank n= 1

Img. 10.5: Star roughness

After adjustment of the parameters for the calculation of star roughness, click the button **Calculate**. The calculated roughness parameters can be stored or printed out by clicking on the button **Save** or **Print** respectively. The window “Star roughness” will be closed by clicking the **Close** button.

10.4. Surface roughness

The parameters for determination of the area roughness are not yet described in standards. Their calculation is performed in dependence on the basic principles of the line roughness determination and by use of algorithms described in the literature. Area roughness parameters include information about the entire surface measured and a larger amount of information (data) is used for parameter calculation. So the area parameters have a greater significance than the line roughness parameters which vary depending on the position of intersecting line, they are more stabile and don’t have as large deviations as to line roughness parameters.

The values of area roughness parameters are only conditionally comparable with the values of line roughness parameters. In the case of the calculation of area roughness parameters instead of line segments, partial areas of the surfaces are used. Keep in mind that only integrative parameters have values comparable with the corresponding line roughness parameters (e.g. Ra). Other parameters have larger deviations (e. g. Rz) because with a greater amount of data points, statistically more data points with larger peak heights occur.

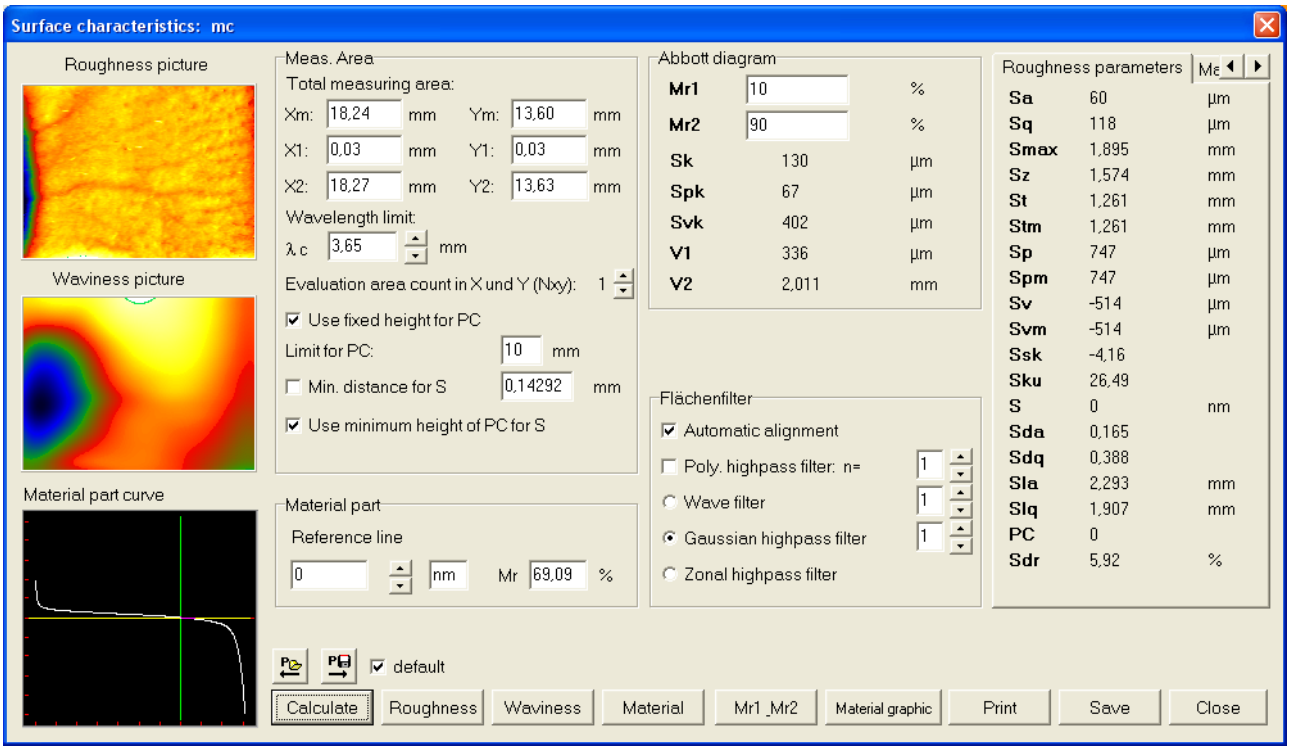
Partial areas with edge lengths Xe and Ye each of 1/5 of the total length of measuring area in x- and y-direction are pre-set. The pre-settings can be changed in the range from 1/3 to1/20 of the total measuring field dimensions. The cut off of the profile filter can be changed within the same range. From these results, a number of possible partial areas from 9 up to 400 arise.

For the calculation of the area roughness, select the menu point **Group evaluation | Surface roughness** or click the icon

. In the window which subsequently opens, set or change the roughness parameters. After adjusting the calculation settings, click the button **Calculate** to start the roughness parameter calculation. In the right of the window, the determined area roughness characteristics will be displayed analogue to the line roughness parameters. The area roughness can also be calculated for a zoomed in part of the measuring area.
Roughness and material parameters can be found in the respective tabs. By clicking the button **Save**, a window for the storage of roughness parameters and/ or material characteristics opens in a text file. By clicking the button **Print**, the roughness parameters and / or the material characteristics will be printed out. By means of the button **Material graphics**, the window for the display of material profiles can be opened (see also section 10.2 “Line roughness” of this chapter).

Hint:

Roughness parameters very much depend on the selected length of cut line and the type of filtering used. Use the filters according to the recommendations of the DIN standards or at least use the same settings for comparison of different parts of surface.



Img. 10.6: Surface roughness

Description of the window elements:

Name of Elements	Description
Roughness picture	Displays the roughness picture.
Waviness picture	Displays the waviness picture.
Material part curve	Displays the Material part curve.
Xm	This displays the size of the measured surface in x-direction, which can be changed.
Ym	This displays the size of the measured surface in y-direction, which can be changed.
X1	This is the x-coordinate origin of the measured surface, which can be changed.
Y1	This is the y-coordinate origin of the measured surface, which can be changed.
X2	This is the x-coordinate end of the measured surface, which can be changed.
Y2	This is the y-coordinate end of the measured surface, which can be changed.
Wavelength limit λc	This is the wavelength limit of the high pass filter (not the polynomial

	Highpass), which can be changed. This parameter has the same value in both the x- and y-directions.
Evaluation area count in X and Y	In the same method as line roughness, here the total measuring surface can be divided by x- and y-direction in a specific or single area. The standard is 1

Name of Elements	**Description**
Use fixed height for PC	When this menu is inactivated, all different heights of the peaks will be included for the determination of Rz-value. In the case of activation, only one fixed height will be take in account.
Min. distance for S	The minimum distance is defined for the distance between the peaks
Use minimum height of PC for S	Only the higher peaks will be included in the calculation of minimum distance.
Automatic Alignment	When this menu is inactivated, the determination of the roughness will start with a second degree polynomial of the original profile. (activated by standard)
Polynomial-Highpass filter n =	A polynomial with the given order is subtracted from the original profile. This filter reduces the waviness very strictly.
Wave filter	This is the first of 3 high pass filters that separate the waviness from the roughness. To the right of this, the number of times the filtering is repeated is displayed. If this number is 0, then it will not occur. The higher this number is set, the more the waviness is separated from the roughness.
Gaussian High pass filter	This is the second of 3 high pass filters that separate the waviness from the roughness. To the right of this, the number of times the filtering is repeated is displayed. If this number is 0, then it will not occur. The higher this number is set, the more the waviness is separated from the roughness.
Zone High pass filter	This is the third of 3 high pass filters that separate the waviness from the roughness. To the right of this, the number of times the filtering is repeated is displayed. If this number is 0, then it will not occur. With all other settings, the filter is run through once.

Reference line	This value defines the reference plane for the parameter Rtpi. See below tables for more information about it.
Mr1	Mr1 is the material part of the peaks without the flat in percent.
Mr2	Mr2 is the material part of the valleys without the core profile in percent.
Calculate	Calculate the roughness parameters with the current settings.
Roughness	The area roughness window is closed and the roughness is displayed in the topographic mode.
Waviness	The area waviness window is closed and the waviness is displayed in the topographic mode.
Material	The material parameters are calculated with the current settings.
Mr1 & Mr2	By clicking this button, the roughness parameters Mr1 and Mr2 will be determined
Material Graphic	Displays the material graphical representation

Name of Elements	**Description**
Print	Prints the result
Save	Saves the result.
Close	Closes the window.

Description of parameters:

Name	**Abbreviation**	**Description**
Arithmetic Roughness	Sa	Sa is the arithmetic mean of the surface roughness. Sa is a vertical parameter. This means it describes the roughness in vertical direction. $Sa = \frac{1}{nx * ny} * \sum_{i=1}^{nx} \sum_{j=1}^{ny} R(x_i, y_j)$
Quadratic Roughness	Sq	Sq is the quadratic mean of the surface roughness. If more than a single measuring surface is appointed, then Sq is the mean of the single measuring surfaces.

		Sq is a vertical parameter. This means it describes the roughness in vertical direction. $Sq = \sqrt{\frac{1}{nx * ny} * \sum_{i=1}^{nx} \sum_{j=1}^{ny} R^2(x_i, y_j)}$
Maximum stretching of the roughness profile	Smax	This is the height difference between the highest peak and the lowest valley on the entire measuring field. Smax is a vertical parameter.
Ten point height	Sz	Sz is the mean of the 5 highest peaks and 5 deepest valleys from the entire measuring field. Sz is a vertical parameter. This means it describes the roughness in vertical direction. $Sz = \frac{\sum_{i=1}^{5} \lvert Rp_i \rvert + \sum_{i=1}^{5} \lvert Rv_i \rvert}{10}$
Greatest roughness depth of the single measuring field	St	St is the greatest height difference in a single measuring field. If the single measuring field number is equal to 1, then St = Stm = Smax. St is a vertical parameter.
Averaged roughness depth	Stm	With the calculation of Stm, the difference between maximum and minimum is formed for each single

Name	Abbreviation	Description
of the single measuring fields		measuring surface. These are added up and then divided by the number of single measuring surfaces. Stm. Is a vertical parameter. This means it describes the roughness in vertical direction
Height of the greatest profile peak	Sp	Sp is the height of the greatest profile peak in the entire measuring field. Sp is a vertical parameter.
Mean of the height of the the profile peak	Spm	Spm is the arithmetic mean of the highest profile peak within a single measuring field over all single measuring fields. Spm is a vertical parameter. This means it describes the roughness in vertical direction.
Depth of the greatest profile valley	Sv	Sv is the depth of the greatest profile valley within the entire measuring field. Sv is a vertical parameter.
Mean of the depths of the profile valleys	Spm	Svm is the arithmetic mean of the deepest profile valley within a single measuring field over all single measuring fields. Svm is a vertical parameter. This means it describes the roughness in vertical direction.
Skewness	Ssk	Ssk is a measure for the a-symmetry of the amplitude density curve. A negative skewness indicates a surface with good carrying behaviour. For a normal dispersion of profile values, Ssk = 0. Ssk is a vertical parameter. This means it describes the roughness in vertical. direction. $Ssk = \frac{1}{nx * ny * Sq^3} * \sum_{i=1}^{nx} \sum_{j=1}^{ny} R^3(x_i, y_j)$
Slope (Kurtosis)	Sku	Sku is a measure for the slope of the amplitude density curve. For a normal dispersion of profile values, Sku = 3. Sku is a vertical parameter. This means it describes the

		roughness in vertical. $Sku = \frac{1}{nx * ny * Sq^4} * \sum_{i=1}^{nx} \sum_{j=1}^{ny} R^4(x_i, y_j)$
Middle distance of the profile peaks	S	S indicates the middle distance of the profile peaks in the roughness profile. The minimum height for a peak is the value 0. In the settings, a counting threshold in horizontal direction can still be defined. S is a horizontal parameter.

Name	**Abbreviation**	**Description**
Arithmetic mean of the profile slope of the roughness profile	Sda	Sda is the arithmetic mean of the local profile slope in x- and y-direction. Sda is a mixed parameter. This means it describes the roughness in vertical and horizontal direction.
Quadratic mean of the profile slope of the roughness profile	Sdq	Sdq is the quadratic mean of the local profile slope in x- and y-direction. Sdq is a mixed parameter. This means it describes the roughness in vertical and horizontal direction.
	Sla	Sla is derived from sda and is calculated through the below formula. $Sla = 2 * \pi * \left(\frac{Sa}{Sda} \right)$
	Slq	Slq is derived from sdq and is calculated through the below formula. $Slq = 2 * \pi * \left(\frac{Sq}{Sdq} \right)$
Number of peaks	PC	PC is the number of peaks in the entire measuring path. For this parameter, a setting parameter is available, which is specified in the text under the description of the window elements further above.
Surface surplus of	Sdr	Sdr is the surplus of the curved surface to the even

the curved surface		evaluation surface. This value is given in percent. Sdr is a vertical parameter. This means it describes the roughness in vertical. $Sdr = \frac{Ao - Ae}{Ae} * 100\%$
Depth of the roughness core	Sk	Sk is the height difference between the material portions Mr1 and Mr2.
Reduced peak height	Spk	Spk is the middle height of the protruding peaks, which lie over the material portion Mr1.
Reduced scoring depth	Svk	Svk is the middle depth of the valleys which lie under the material portion Mr2
Material- filled peak surface.	V1	V1 is calculated according to the below formula. A surface in not produced merely through the formula. To receive a surface, the calculated value must be multiplied by the entire measuring field. $V1 = \frac{1}{2} * Rpk * Mr1$

Name	**Abbreviation**	**Description**
Empty valley area	V2	V2 is calculated according to the below formula. A surface is not produced merely through the formula. To receive a surface, the calculated value must be multiplied by the entire measuring surface. $V2 = \frac{1}{2} * Rvk * (100 - Mr2)$

Explanation of the used abbreviations:

nx = Number of points of the evaluation rectangle in x-direction.

ny = Number of points in the evaluation rectangle in y direction.

$R(x_i,y_j)$ = Profile value of the roughness profile at the coordinates x_i and y_j

Rp_i = Profile value of the highest peaks (i = 1 is the highest peak of the roughness profile)

Rv_i = Profile value of the deepest valleys (i = 1 is the deepest valley of the roughness profile)

Ao = Area of the curved surface

Ae = Area of the even base area

Further references to the surface roughness:

So far there are no variable norms for the surface roughness.

With the parameters Smax and St, the meaning in comparison to the line roughness parameters Rmax and Rt have changed.

If not differently set, then when starting the surface roughness dialogue, the entire measuring surface is trimmed to a square which could have the following edge lengths:
0,1 0,2 0,5 1 2 5 10 20 50 etc.
In each case, the next smallest measuring field that fits into the square is chosen.

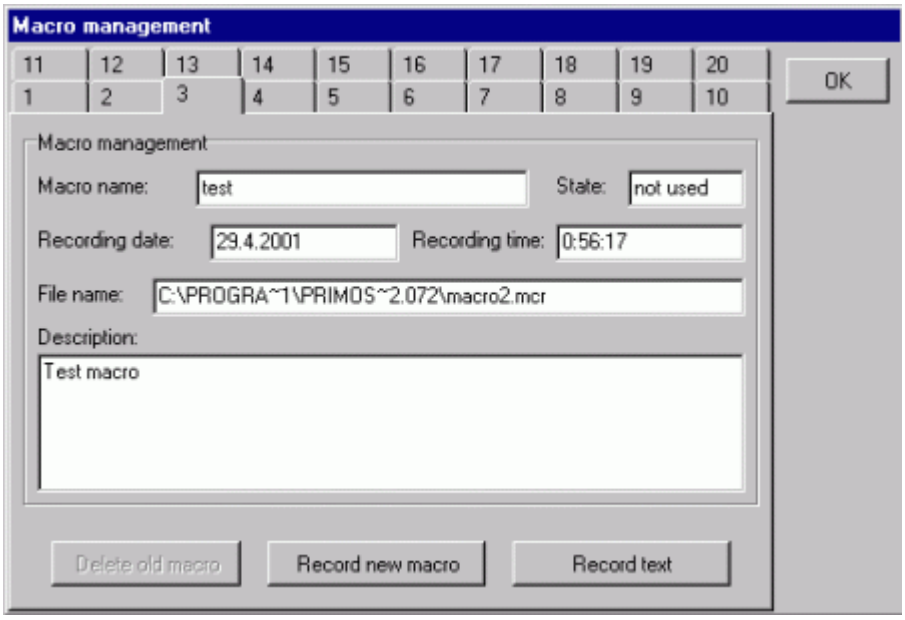
11. Macro function

11.1. General

With the function “Macro“, repeating sequences of functions and evaluation strategies can be saved as a kind of overall function. This can then be called upon when needed without much effort.

11.2. Creating a Macro

Transfer a measured height image to the evaluation window or open a saved height image.
Activate the button **“Start recording“** in the menu **macro** to begin the macro recording.
Conduct the desired evaluation function (e.g. Filter, intersecting line etc.) Step by Step.
After conducting all necessary evaluation functions, activate the button **“Stop recording”** in the menu **Macro**, to end the macro recording.
The window "Macro management" opens.

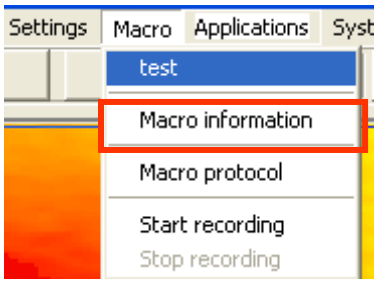


Img. 11.1: Window "Macro management"

Here, enter the **Macro Name** and if necessary, another description.
In the field **Filename**, the path is indicated in which the file is saved.

Date of Establishment and **-time** are automatically saved.
By clicking on the number line at the top boarder of the window, it can be established, which macro numbers are already allocated or, are still free.
If required, a used macro number can be made free (deleted) with the button **Delete old macro**
Select a free macro number (**Status:** “empty“).
Activate the button **Add text** and subsequently **Create new macro** (Status now “taken“).
Close the macro window by pressing the **OK** button.

Now, this macro appears in the menu.



Img. 11.2: Newly added macro function in the Macro menu

11.3. Using a Macro

To open a saved macro, open a height picture and subsequently click in the menu **Macro**, on the corresponding macro function.

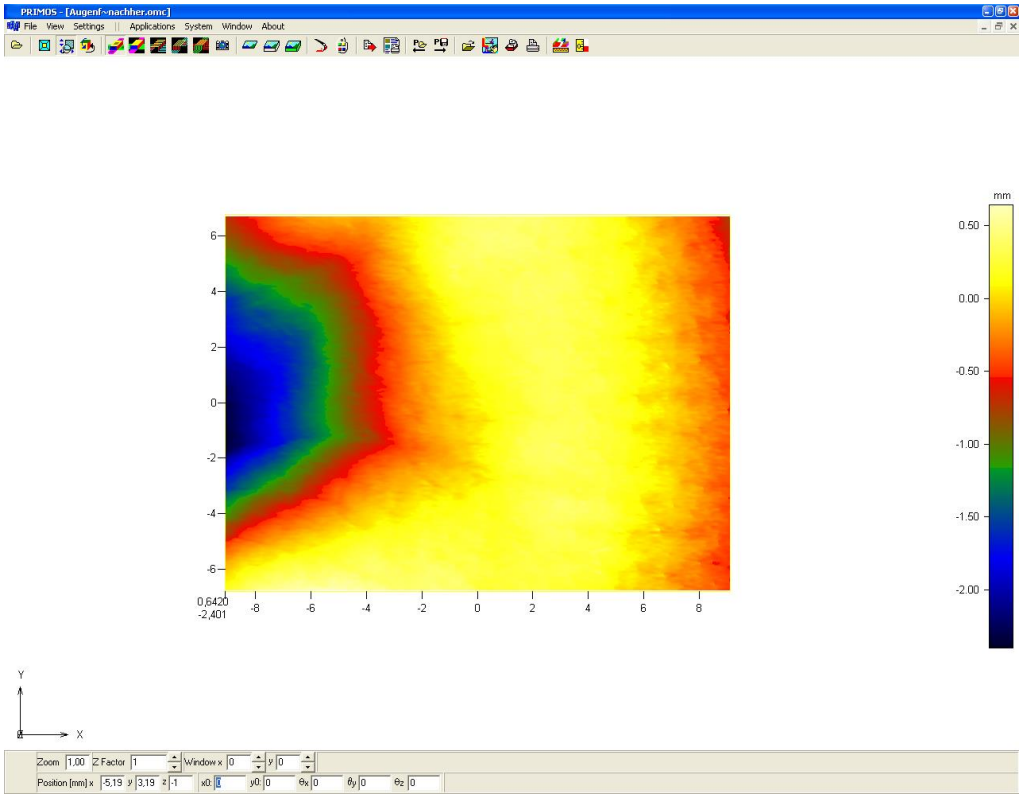
Information regarding the used macro can be found in the Menu **Macro | Macro-Info**.
Under **Macro | Macro-Protocol**, a macro documentation is added which can be blended in on demand.

12. 3D-Depiction

12.1. Zooming and moving the 3D depiction

The 3D depiction is opened through the button

or the menu item **View | 3D representation** in the 3D evaluation program.

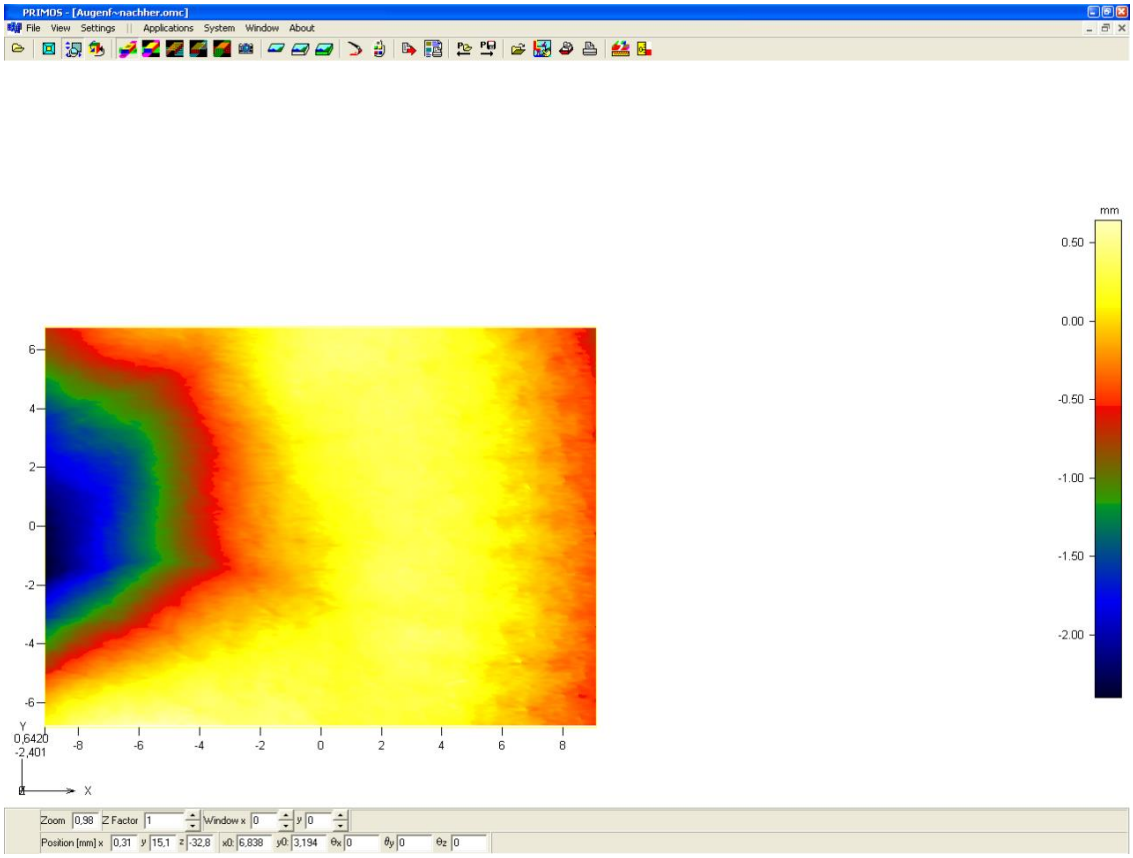


Img. 12.1: User surface for the three dimensional depiction of height images.

After starting the 3D depiction, the height image appears in top view. By choosing a tool through the toolbar or selecting the appropriate tool in the menu item “View” the 3D object can be zoomed in, moved or turned.

Button	Icon	Function
Zoom / move		The depiction can be moved around in the 3D window by moving the mouse around with the right mouse button held down. By moving the mouse while holding down the left mouse button, the image is made smaller or bigger.

Button	Icon	Function
Turning		The depiction can be turned around the z-axis by moving the mouse and holding down the right mouse button. By moving the mouse and holding down the left mouse button, it can be turned in x-y direction.
Restore		By pressing this push button, the 3D image is set back to its original condition. Zooming, displacements and turns are all undone.



Img. 12.2 Reduced and shifted height image

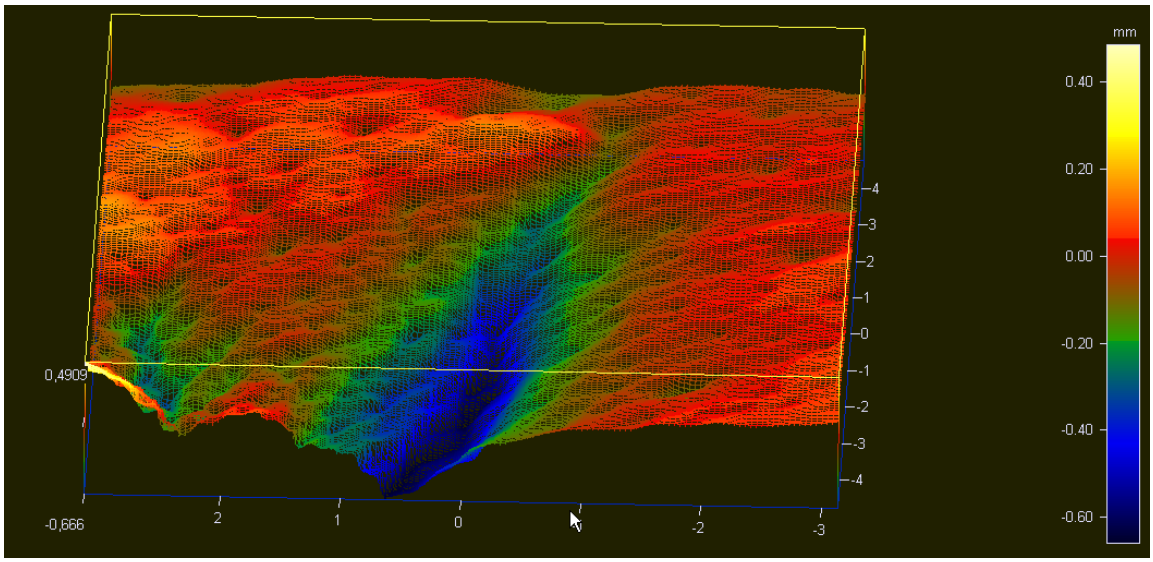
12.2. Settings

Through the tool bar or the buttons of the menus “View“ and “Settings“ various depiction possibilities can be chosen. Depiction parameters can be saved (Button) and loaded (Button).

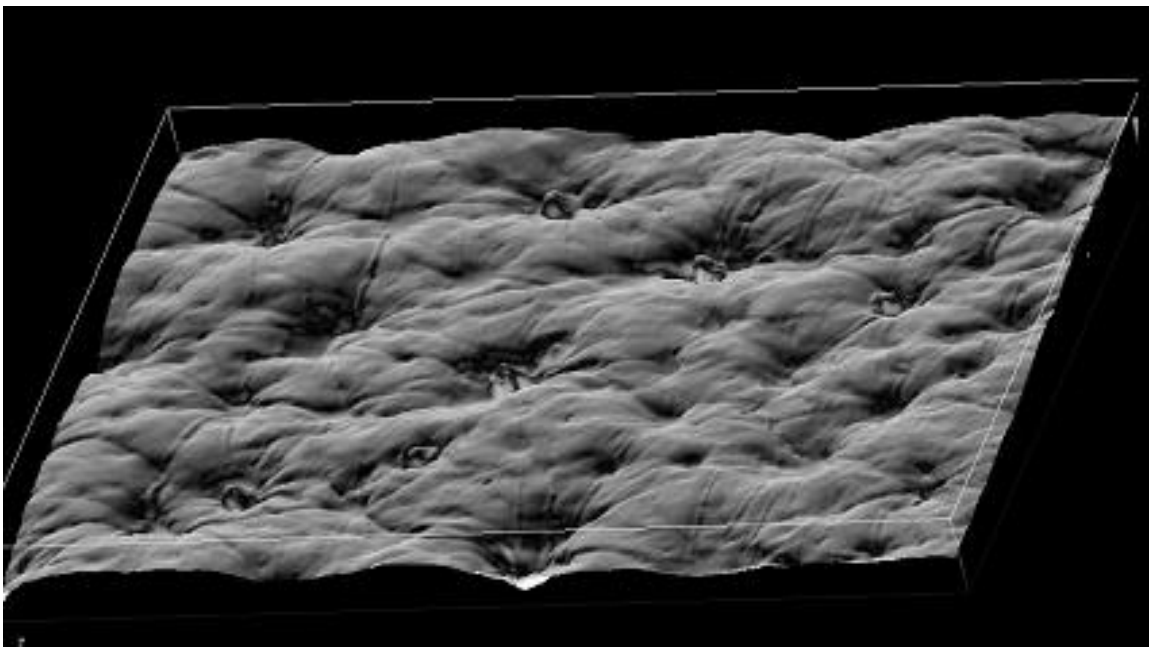
12.2.1. 3D-Depiction

The kind of 3D depiction can be selected on the toolbar or the menu item “View“.

Button	Icon	Function
Height image with reduced resolution.		The 3D surface is depicted colour coded. For its turning, a reduced resolution is used to achieve a faster graphical depiction.
Height image in full resolution		The 3D surface depicted colour coded and in full resolution.
Net progress in x-direction		Grid net depictions (s. Fig. 32) serve the purpose of better visualisation of 3D structures. The running lines can be drawn in the x or y direction as well as in both directions. The line density can be adjusted in the status bar via the input box step X and Y.
Net progress in y direction		
Net progress in both directions		
Photo simulation		For the Photo simulation, (s. Fig. 33) 3D data is depicted as it can be seen by suitable lighting. Great advantages over microscopic viewing result from the fact that limitations of real optical systems regarding lighting possibilities as well as depth sharpness are omitted. In the Photo simulation mode, moving, zooming and turning the depiction is also possible.
Smoothed depiction		The surface of the 3D depiction is smoothed through the use of a filter.



Img. 12.3: Wrinkle at the eye in grid net depiction



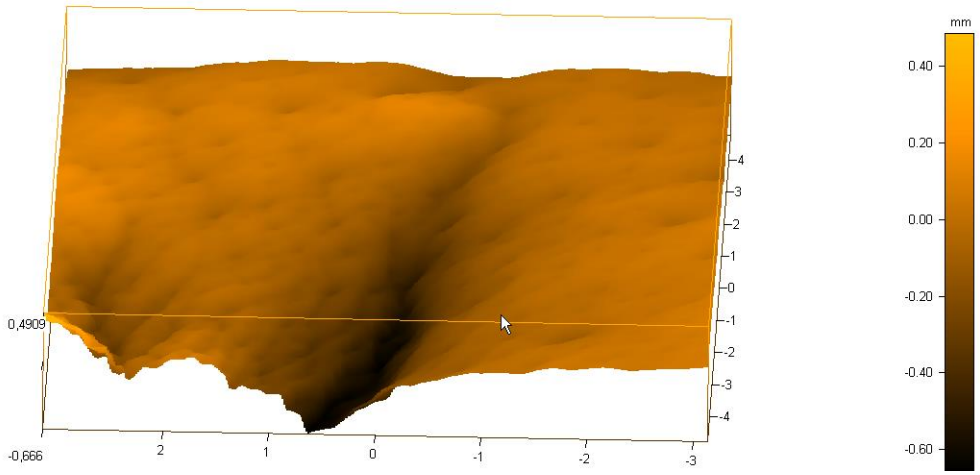
Img. 12.4: Facial area with beard hairs in photo realistic depiction

12.2.2. Frames

Through the menu “View“ or by selecting one of the buttons ,
the various frames can be chosen.
If the frame is switched off, the X-Y- scale is removed.

12.2.3. Colour Settings

Button	Icon	Function
Choose colour palette		Adjusting the colour scaling of the height image = Click pushbutton or symbol – window for choosing colour scaling of height images opens; Choose desired colour scaling with the left mouse button and press OK to confirm choice.
Choose back ground colour		Adjusting the back ground colour for the 3D-depiction = Click pushbutton or symbol; In the window which opens, enter colour values or choose colour via mouse click in the colour field and confirm choice with ok.
Use current view parameter as default.		After activating this option, subsequent opened height pictures will be displayed in the same position and enlargement in which the corresponding height image could be found upon activating the option.



Img. 12.5: 3D-Depiction of a surface with changed colour palette and back ground colour

12.2.4. Scaling

Button	Function
Automatic Z-Scaling	Automatic height scaling = Activate pushbutton – an even colour dispersion from the lowest to the highest measuring point is used for the scaling of the height image. (Standard scaling)
Free Z- Scaling	Free height scaling – Possibility of colour emphasis of small elevated areas = Activate pushbutton; change min. and max. height values in the window which opens; Click “OK” – The scaling area of the height image is changed.

12.2.5. Adjusting the Z Distortion°

In the status bar under 3D depiction, the Distortion factor of the z coordinates can be set. (s. Fig. 35).

12.3. Exporting and Printing

Button	Icon	Function
Export		Export the displayed 3D depiction in a graphic format = Click pushbutton; Enter file name; choose file format and directory for saving; click “save”
Copy to printer folder		Copying the displayed 3D depiction into the clip board for the following use in the print out folder (s. chapter “Print folder “) =click pushbutton or symbol

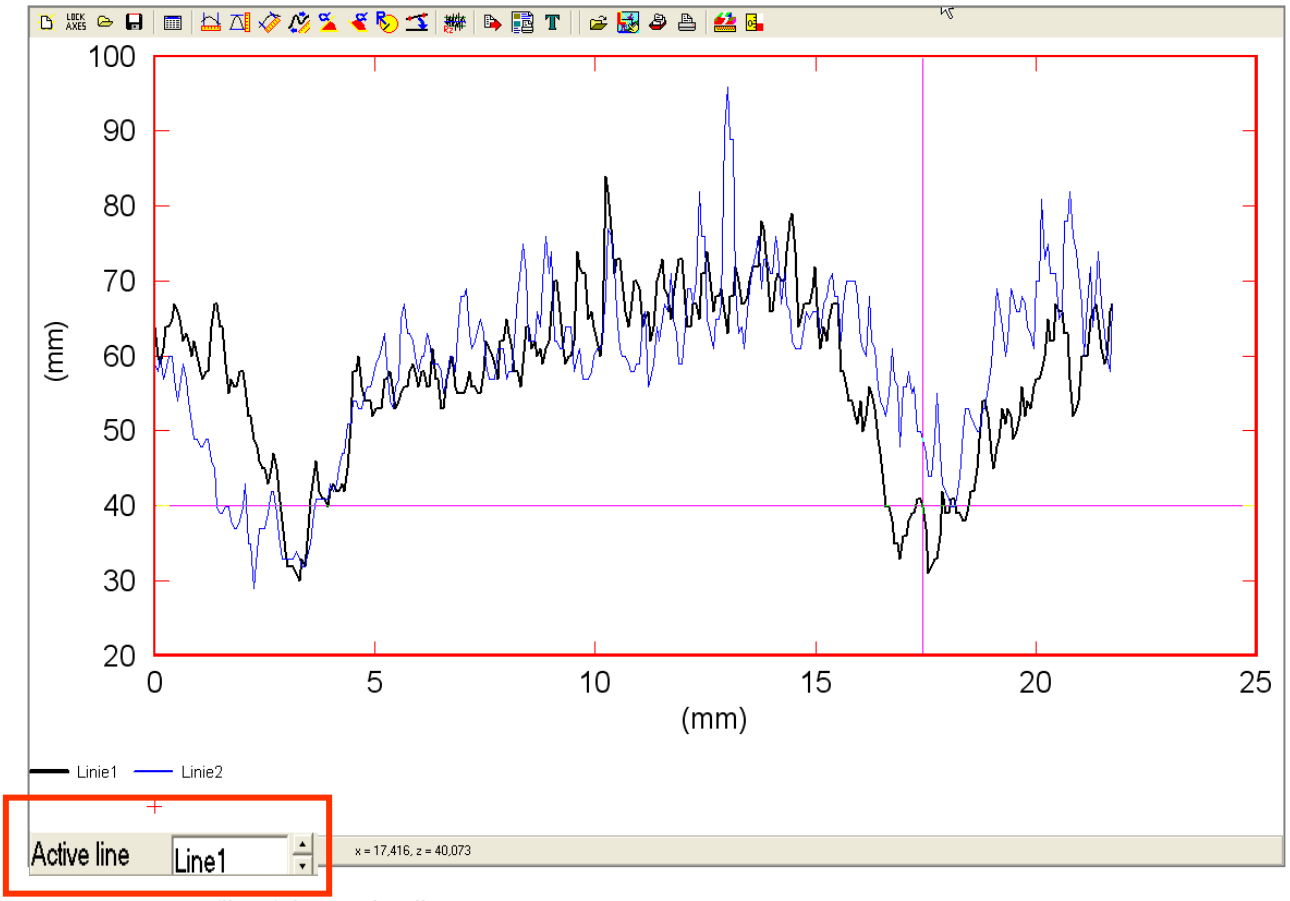
Further information regarding the use of the above mentioned functions can be found in chapter 20 “Brief Description of the program functions in the measuring, control and evaluation software“.

13. Intersection Lines

13.1. General

For the display of an cross section after drawing an intersecting line in the color coded height image, press the button Details or the menu item **View | show sectional picture** in the 3D evaluation window.

Several intersecting lines can be displayed in the cross section. One of these lines is active which means, dimensioning, alignments filtering and calculations can be undertaken. To activate a specific line, choose it in the status bar, using the scrolling button (see Fig. 13.1). The active line is displayed thicker.

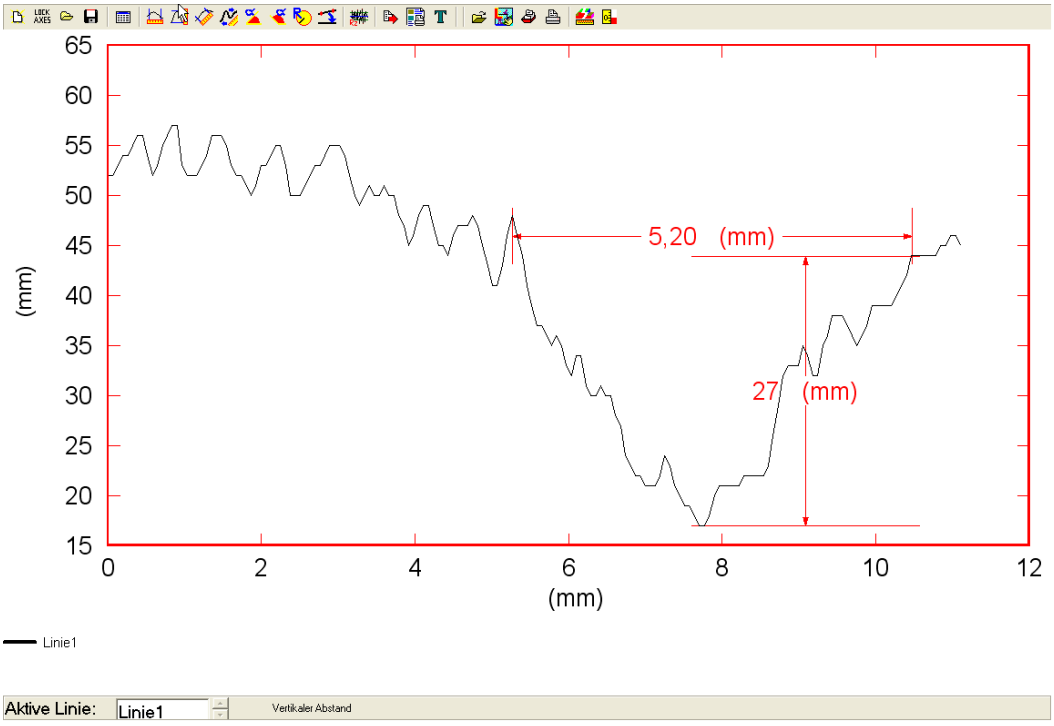


Img. 13.1 Profile of the cutting lines

13.2. Measurement of Gaps

The program makes it possible to measure distances in x-y direction, height differences and real distances (shortest distance = linear distance) of two points. To conduct this measurement, proceed as follows:

Activate the intersecting line by use of the scroll button.
Mark the two points on the intersecting line between which the distance is to be measured.
By clicking the right mouse button, all marked points are deleted.
Select the gap type to be measured through the menu “Geometry“or by clicking one of the following buttons: Horizontal distance , Vertical distance , real distance , curve length .
The distance is displayed.
The position of the result display in the depiction can be changed by moving the cursor over the result. Clicking and moving the cursor with held down mouse button to the desired position.
By moving the cursor over the result display and subsequent clicking of the right mouse button, the result display is deleted.

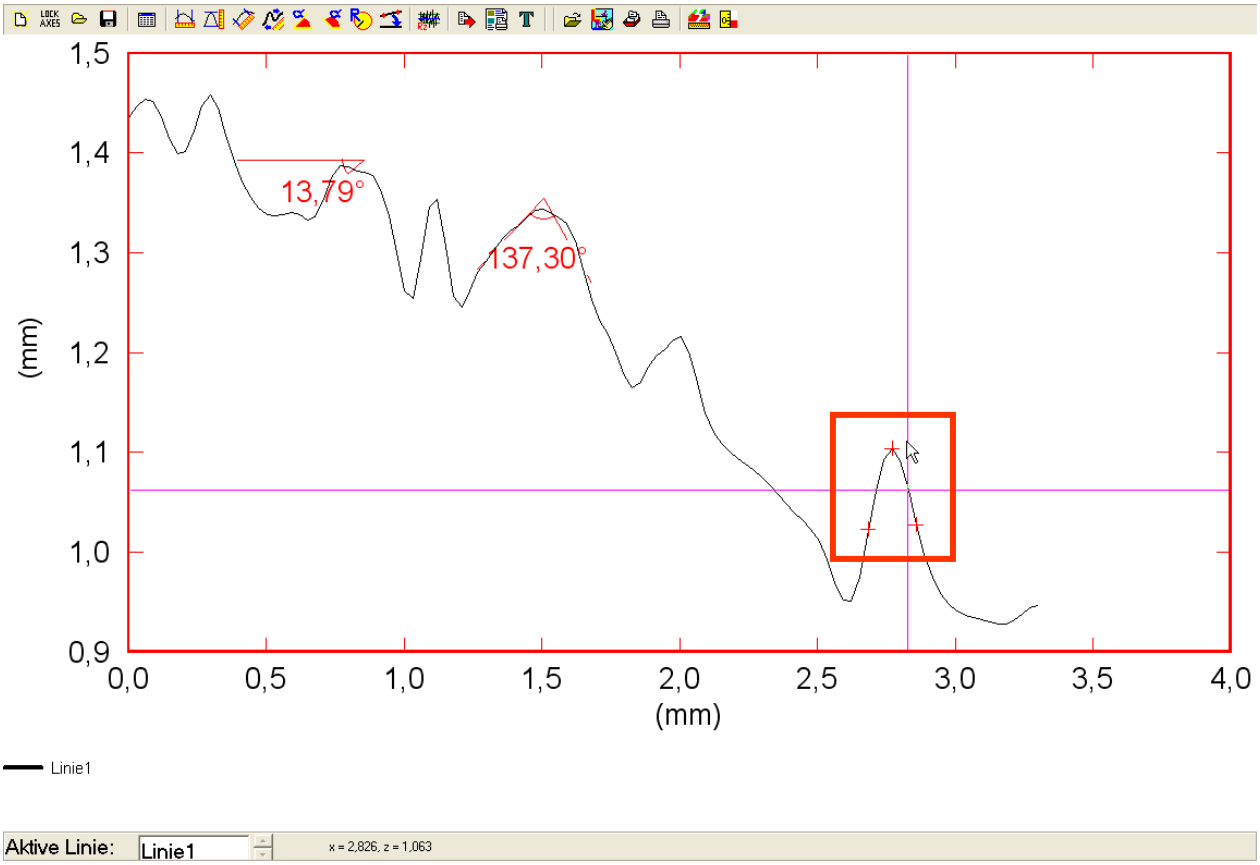


Img. 13.2: Dimensioning of distances in the cross section

13.3. Angle Measurement

The program makes it possible to measure the angle between a line of best fit and a horizontal or two lines of best fit. Please note, that the X and the Y axis can be differently scaled, depending on the selected enlargement and so the angle can be displayed distorted. To display an angle proportionally, select the menu item **View**

| Real XY Ratio or **Zoom | 1**.



Img. 13.3: Dimensioning of angles in the cross section

Angle to the Horizontal:

Activate the necessary intersecting line.

By clicking on the left mouse button, mark two points on the intersecting line.

Select the menu item **Geometry | angle (acute)** or select the push button .

The acute angle to the reference plane is shown (Fig. 13.3).

Alternatively, the menu item **Geometry | angle (obtuse)** or the push button can be selected, to show the obtuse angle to the reference plane.

Angle between the lines of best fit of two curve parts:

Activate the required intersecting line.

By clicking the left mouse button, mark three or four points on the intersecting line. (Fig. 13.3).

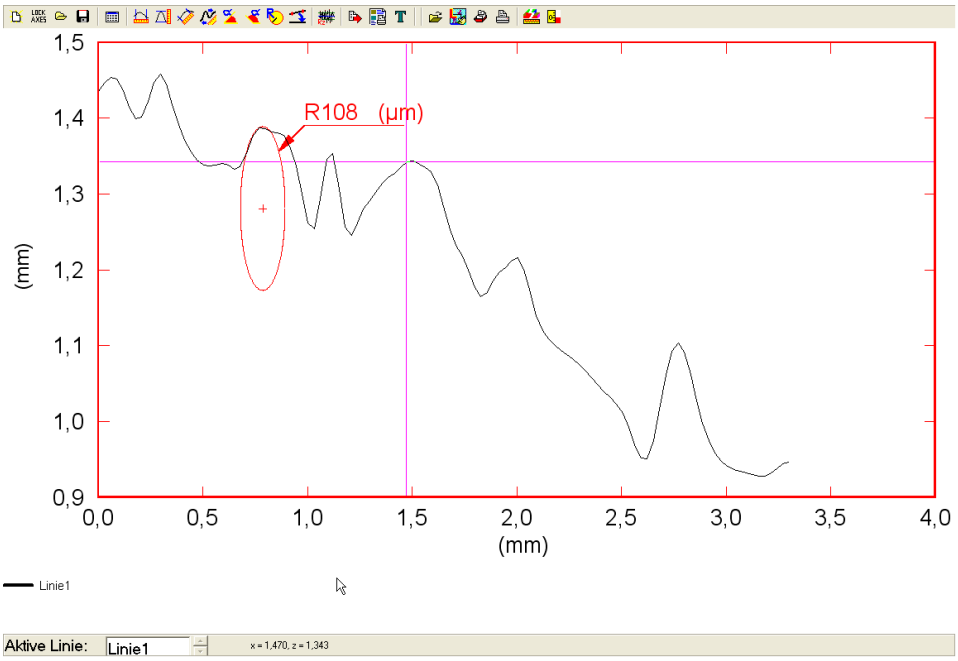
Select the menu item **Geometry | angle** (acute or obtuse) or activate the button

/ .

The angle between the line of best fits P1-P2 and P2-P3 or P1-P2 and P3-P4 are displayed.

13.4. Determination of Radii

For the determination of radii there are two possibilities. By marking two points on the intersecting line, the space in between these two points is examined and an appropriate range with an existing curvature radius is automatically detected. For the determination of the radius, only the points in the range of the curve are used.



Img. 13.4: Dimensioning of Radii

If all points of the circle curve are to be used for the determination of the circle radius, the circle segment must be marked with three points.

Subsequently, select the menu item **Geometry | Radius** or the button , to display the value of the radius. (Fig. 13.4).

13.5. Roughness Parameters

For the calculation of roughness parameters, select the menu item **Parameter | Roughness parameters**. More concerning roughness calculations can be found in the chapter “Roughness Parameters“.

Once the roughness parameters have been calculated, the menu item **parameters** can be selected in which in can be decided whether the **roughness profile**, the **waviness profile** or the

material proportion curve is displayed. To display the cross section again, select the menu item **File | Redraw** or press the button .

13.6. Intersecting lines of various height images in one view

The software makes it possible to use one intersecting line with firmly defined parameters on varying height images and to insert all cross sections into one view:

Open or create height image (measure and shift in the evaluation area)

Create and display an intersecting line (see chapter “Evaluation of 3D data“)

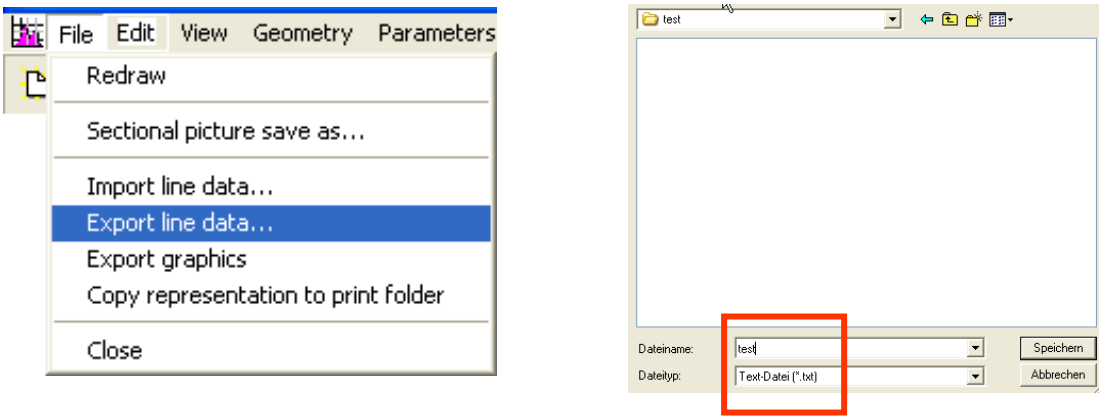
Save the intersecting line in the cross section window as “***.txt*** “(Menu item **File | Export Line Data...**).

Close cross section window

Copy and or save the coordinates of the intersecting line from height image into the clipboard. (Menu item **Edit | Copy Parameter**) or (Menu item **Edit | Save Parameter**).

Open or create new height image (Measure and move into the evaluation area).

Load the previously assigned parameters of the intersecting line (Menu item **Edit | Insert parameter** or **Edit | Open parameter**) and display the cross section.

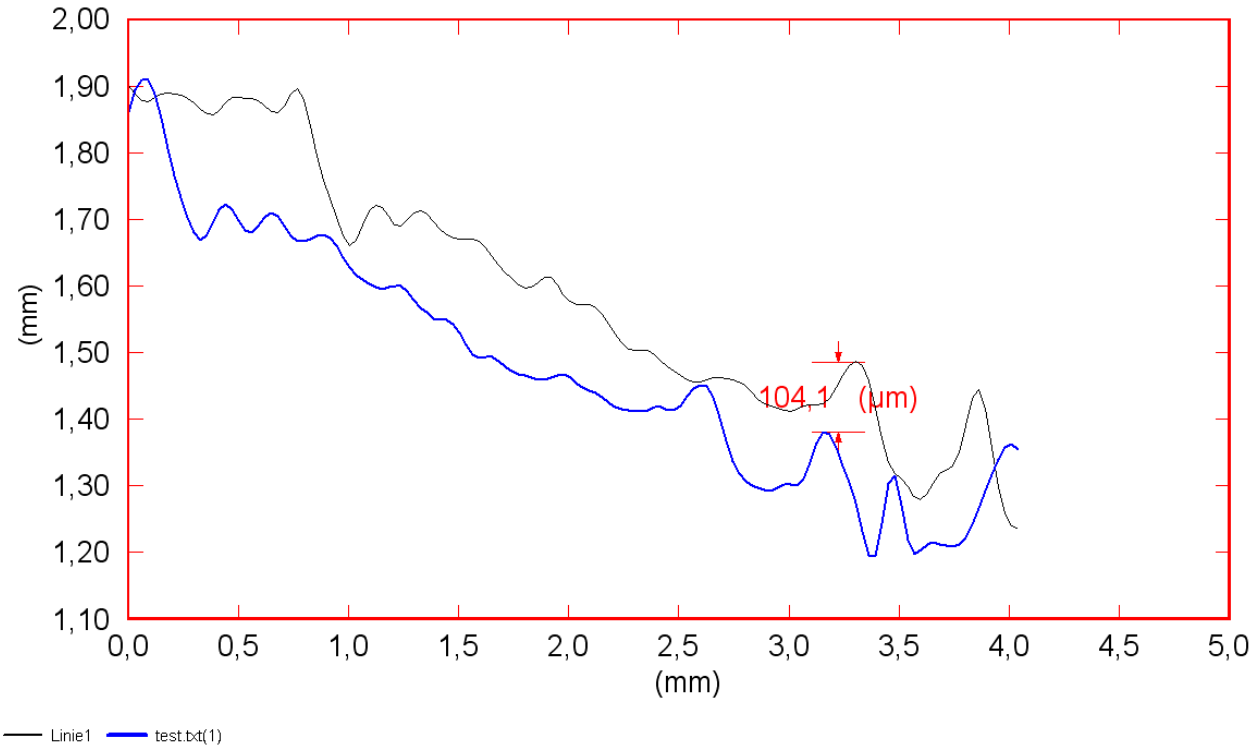


Img. 13.5: Option “Export Data“

Load the previously saved txt-file in the cross section window (Menu item **File | Import Data** or button).

In the status bar on the bottom right, the field “active line“ can be found. Activate the required intersecting line using the scrolling button.

Measurements are also possible between varying intersecting lines. For this, activate the respective line before you mark a point and subsequently, conduct the distance measurement as described above.



Img. 13.6: View from several height images

Further information regarding the usage of the above mentioned functions can be found in chapter 20 “Brief description of the program functions in the measuring, control and evaluation software – Toolbar“.

14. 3D-Matching of Elastic Surface Structures

14.1. Requirements

A prerequisite for the 3D matching is the availability of two height images of the same area of the measuring object or at least with sufficient overlapping areas. The height images need the same dimensions and resolution, as well as both having a micro structure with adequate characteristics.

14.2. Automatic alignment (Matching)

- **Main fields of application for 3D Matching**

Analysis of changing processes of the human skin (Through use of cosmetics, healing processes, sicknesses, surgery etc.)
Analysis of structural changes that can be characterised by roughness parameters.
Analysis of height changes of wrinkles e.g. in the eye area.

- **General Functionality of 3D-Matching**

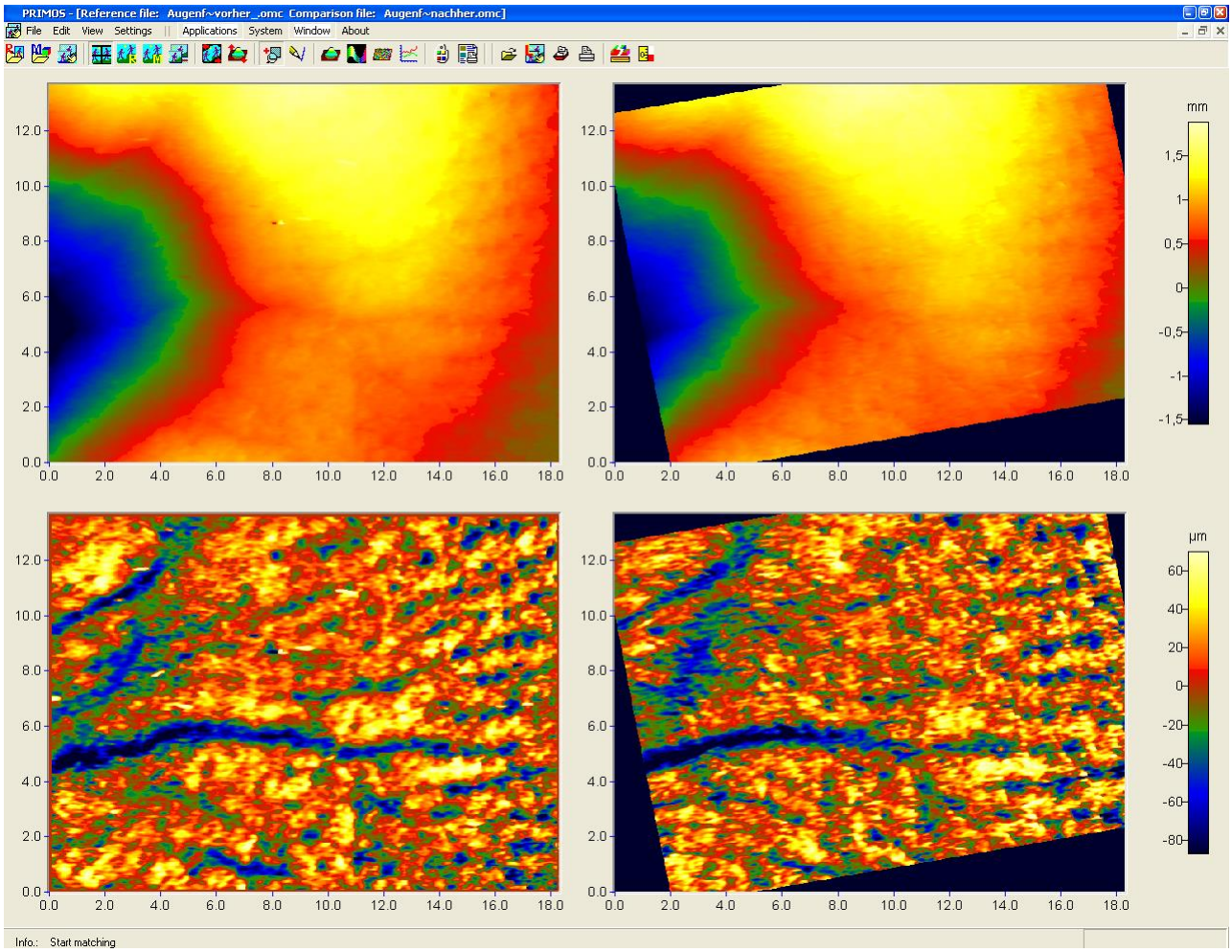
A manual pre-aligning of the height images is not necessary. The aligning occurs automatically, based on the analysis of the micro structure of both height images in all degrees of freedom (shifting along all 3 axis, turning around the Z-axis, small tilting in the X-Y- level). Through use of the micro structure, stretches and deformations of the test sample can be recognised, taken into account and analysed.

- **Work Steps for the execution of the 3D matching:**

Opening of the matching window. (Menu item **Applications | Matching for elastic surfaces** or press button) – A window with four initially empty display surfaces is opened.

Opening the reference file (Menu item **File | Open reference** or press button), that is to be matched with a second file.
Opening the file that is to be matched. (Menu item **File | Open measuring data** or press button)
On the left, the reference picture is opened with its micro structure displayed below. To the right is the file that is to be matched.

Begin matching (Menu item **Edit | Start matching** or press button). This then proceeds automatically and can take up to several minutes, depending on the capacity of the computer.
After completion of the aligning process, the measuring data is displayed in the best possible alignment to the reference data (s. example below in Img. 14.1).



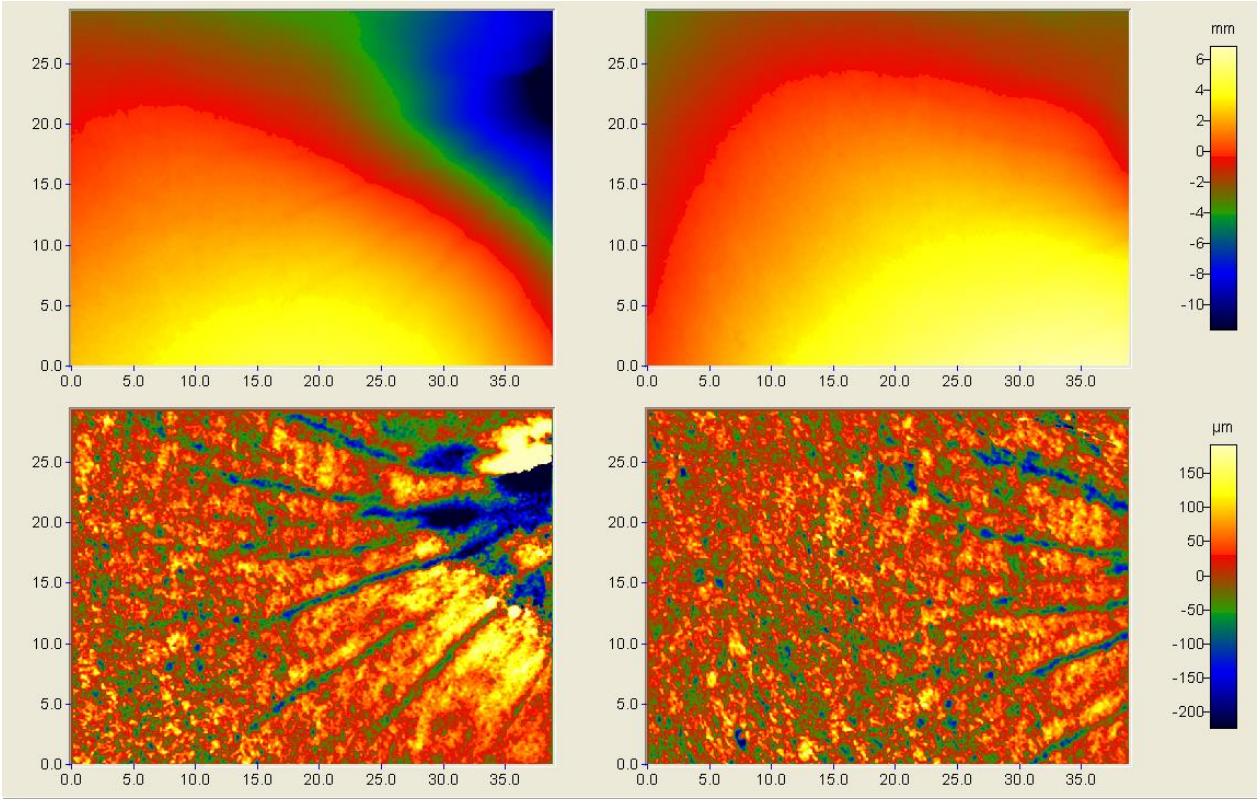
Img. 14.1: User surface for the automatic alignment (matching) of height images – Aligned files of wrinkles in eye vicinity

Fig. 14.1 shows reference data in the left side of the picture and the measuring data in the right side. In the bottom area of the figure the micro structure of the skin is shown for a better comparison of the height images. Because a pre-alignment during the measuring procedure is only possible to a certain extent, non overlapping parts of the height image are displayed after the matching without data. These parts of the height image can be filled with data from the reference file.

- **Possible sources of error during the 3D matching process**

In the case of too large positional deviation from between reference image and measuring data, a correct alignment of the two data sets is not possible. In this case, the fitting surface area should be re-measured. Generally, a systematic approach to the positioning of the test object / person to

the varying points in time of the measuring process is important. Another source of errors is strong deformations that, e.g. can come from the production of replicas. In these cases the change over to in vivo measurements, where the sources of error such as deformation through the manufacture of replicas are avoided. If both height images do not share enough characteristics, a correct aligning is also not possible. To many hairs in the height images of the skin areas which are to be matched can also lessen the chances for a successful alignment because they present interferences for the optical 3D measurement of the skin surface.

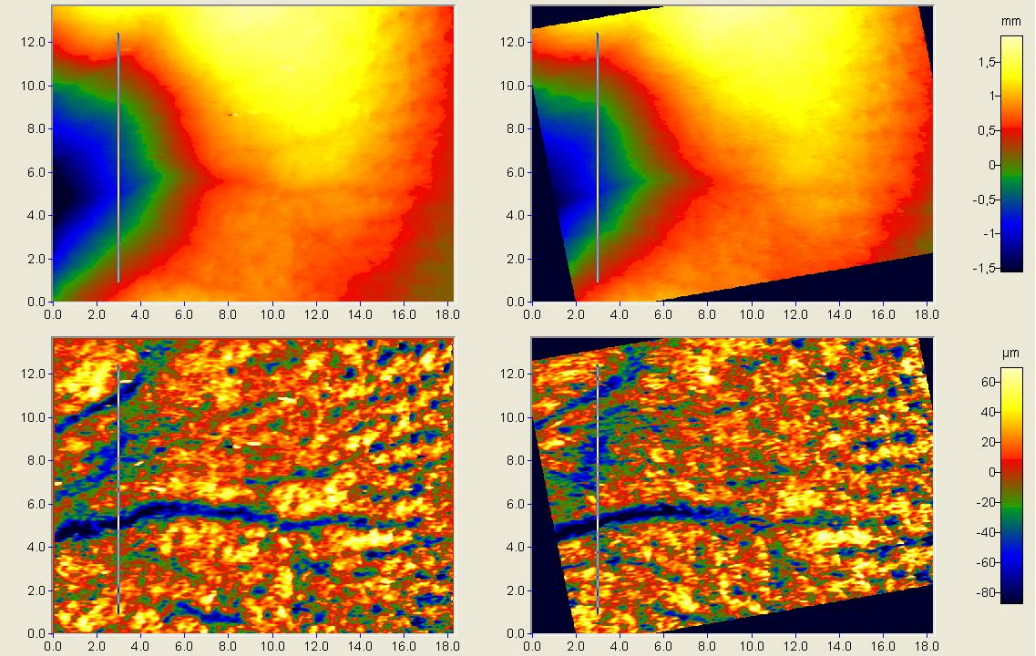


Img. 14.2: Two Height images of “crows feet” with very little overlapping area

14.3. Evaluation

14.3.1. Comparison of Intersecting lines

For simple comparisons, an intersecting line can be laid into the height image. For this, activate the intersecting line tool in the menu item **Edit | Draw line** or activate the button . Position the cursor at the starting point of the line and move it with held down left mouse button. The intersecting line is drawn simultaneously in the reference and measuring data.



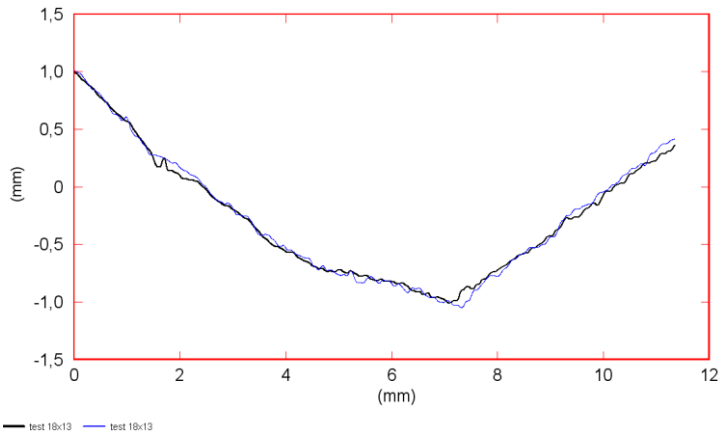
Img. 14.3: Reference and measuring data with marked intersecting line

Subsequently, choose one of the three types of cross section displays by clicking the corresponding button. (s. Img. 14.3):

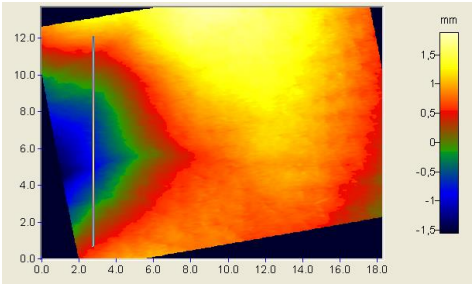
Img. 14.4: Selection of the type of cross section display

The following types of cross section display are available:

- **Cross section display of the height image -** Menu Item **View | Original height picture** or



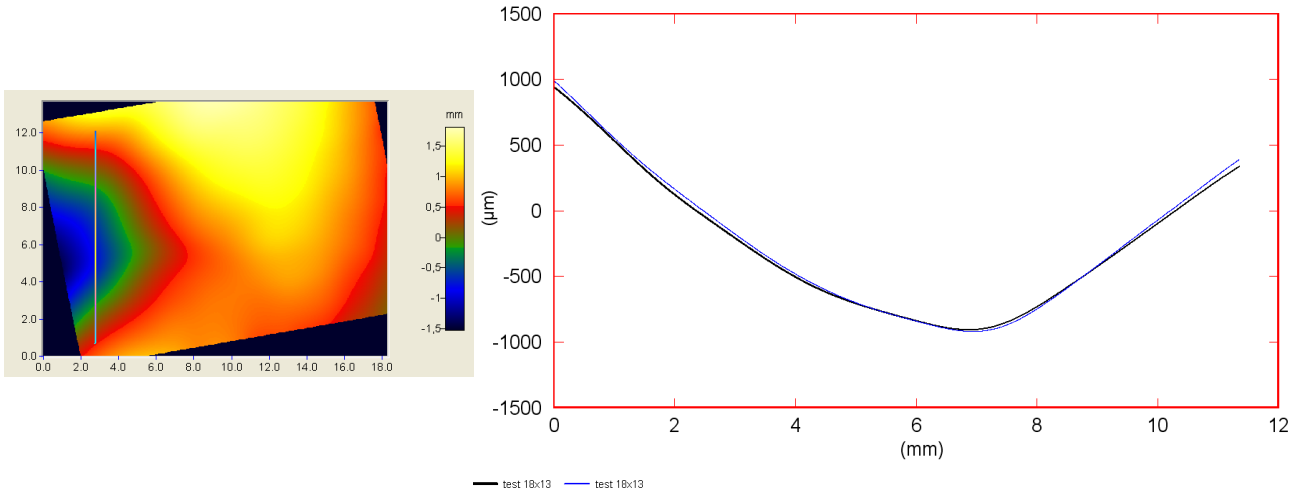
button



Img. 14.5: Original height image with cross section display

In this case, the complete height structure with waviness and roughness (Macro and Micro structure) is displayed in the cross section.

- **Cross section of the fine structure height image -** Menu item **View | Fine structure height**

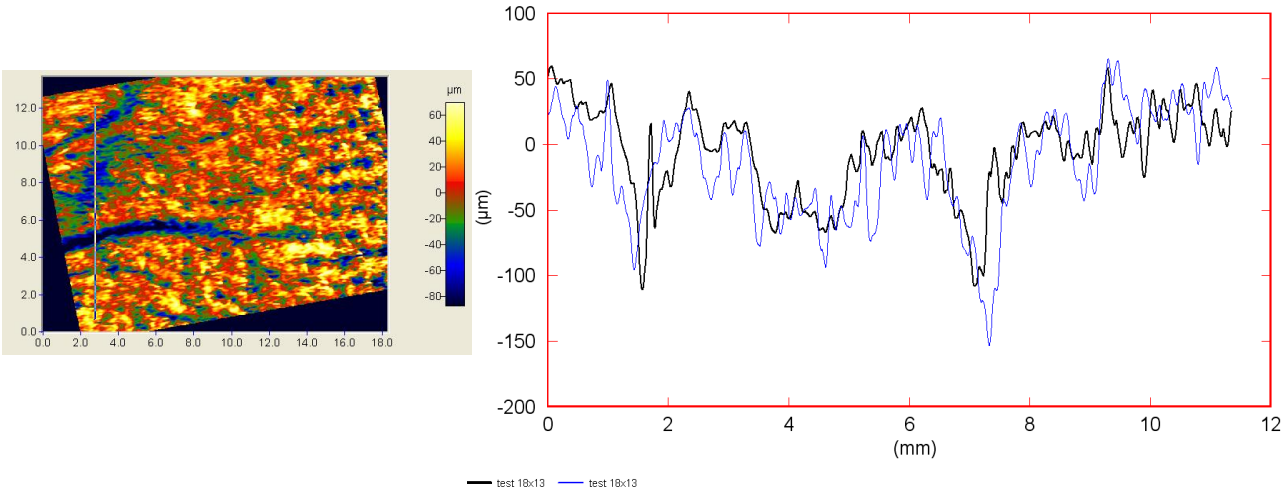


Img. 14.6 Fine structure height image with cross section display

picture **or button**

Here, only the waviness is displayed in the height image. (Macro structure). The fine micro structure is filtered out.

- **Cross section of the rough structure height image –** Menu item **View | Rough structure height picture** or button



Img. 14.7 Rough structure height picture with cross section display

Here, only the roughness (Micro structure) is displayed in the cross section. The macro structure is filtered out.

Select the menu item **View | Show sectional picture** or click the button). The chosen section type is displayed.

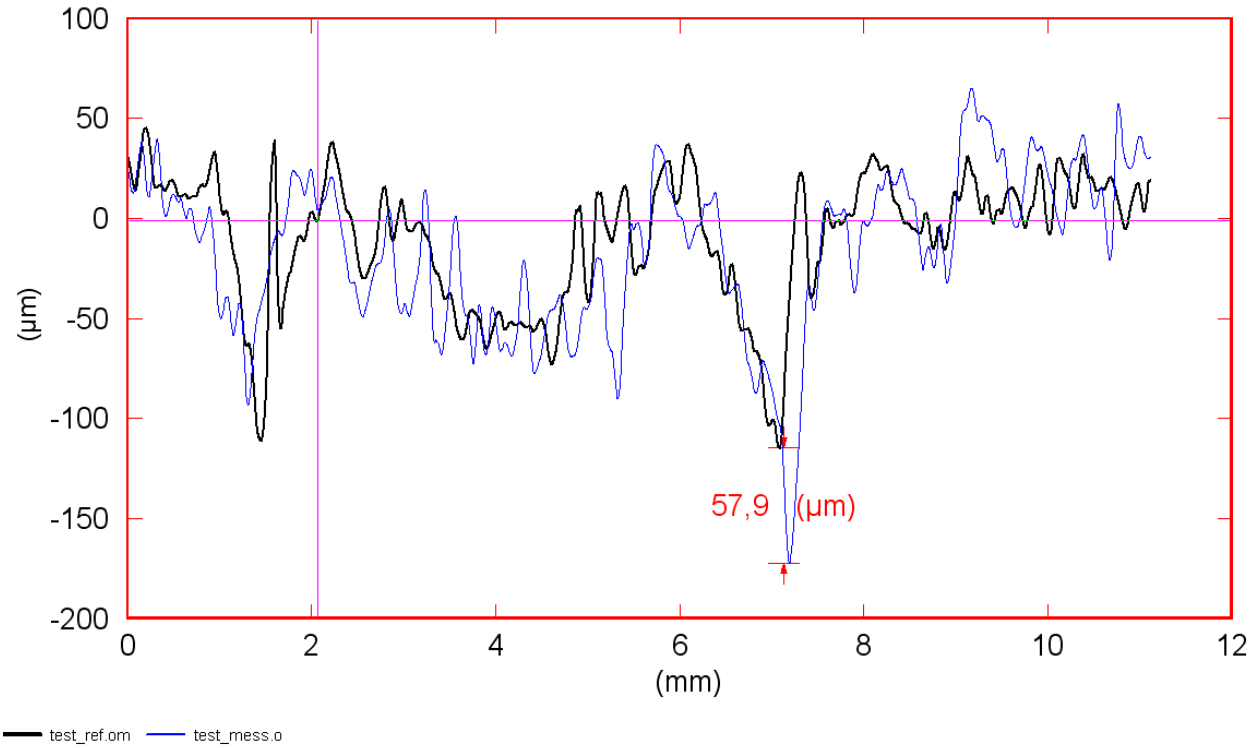
- **Data evaluation in the “Cross section“ window**

Now, measurements and dimensioning can be conducted in the cross section (s. Chapter “Intersection lines“). For this purpose, mark points on the intersecting line, between which are to be measured and subsequently, choose the size to be determined in the menu “Geometry“ or by clicking on the corresponding button.

Img. 14.8: Buttons for the intersecting line evaluation.

Points are always marked on the active intersecting line. Select the active curve intersecting line with help of the scroll button on the status bar.

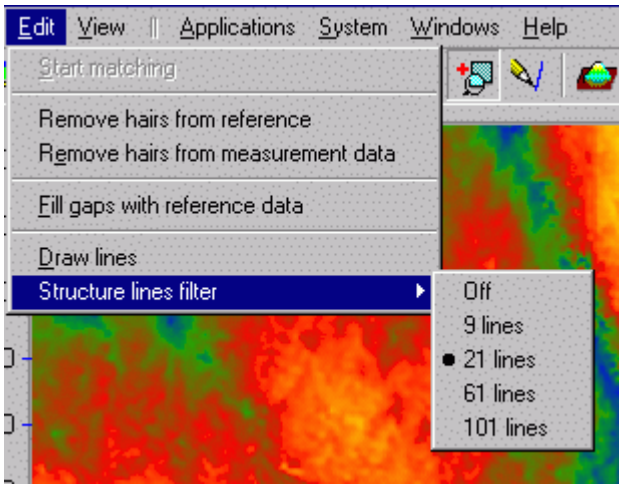
Img. 14.9 Menu “Active line“



Img. 14.10: Comparison between reference and measurement data via intersecting line

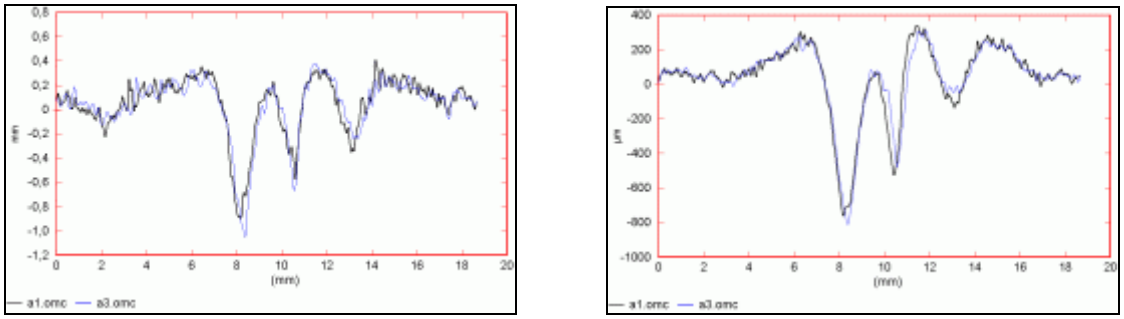
- **Structure line filter**

The structure line filter serves the averaging of close together lying intersecting lines. This is especially useful when rough structures are being measured (e.g. deep wrinkles). To minimize accidental errors, it sensible to average several neighbouring intersecting lines. To activate the structure line filter and determine the number of lines, select the menu item **Edit | Structure line filter**.



Img. 14.11 Structure line filter

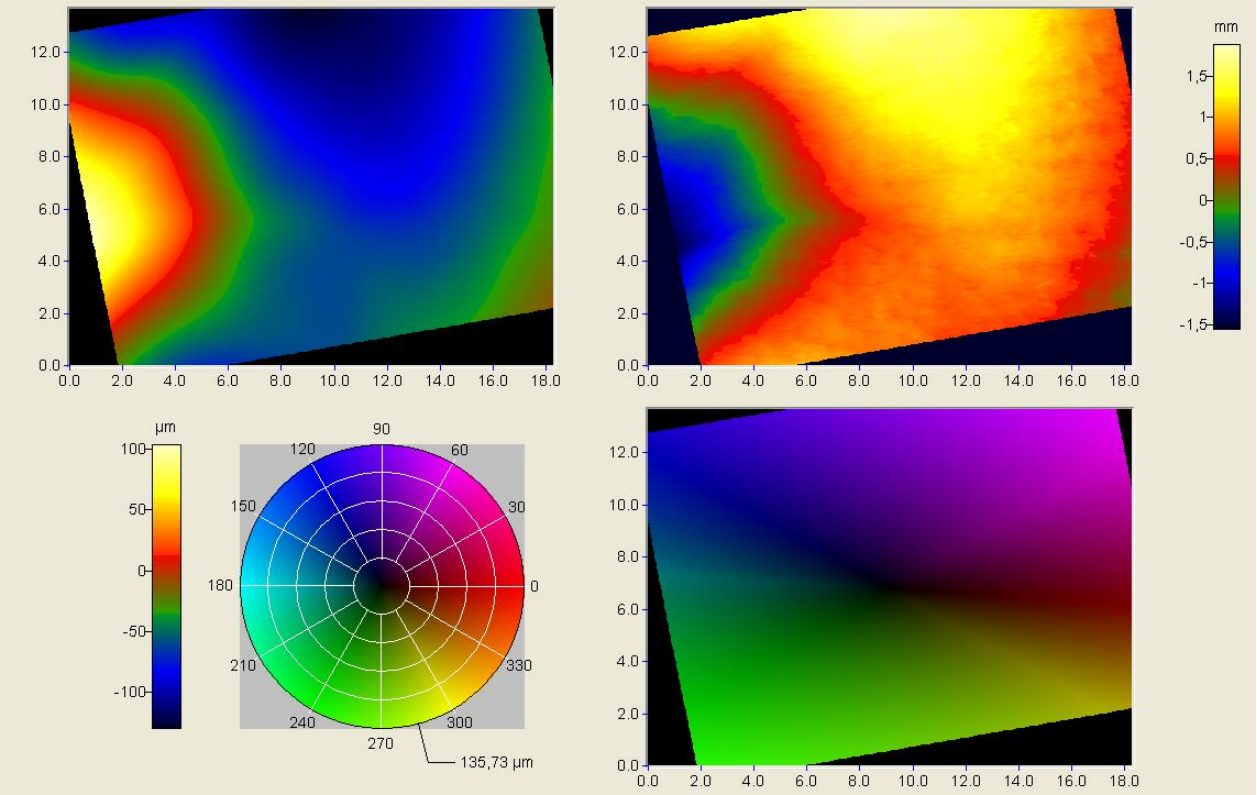
Warning! The more lines that are used for the averaging, the more the real intersecting line is smoothed out. Therefore, the number of lines should be chosen with great care. (s. example fig. 14.12).



Img. 14.12 averaging over 61 lines

14.3.2. Analysis of Deformations

With the deformation analysis, the degree of consistency between the reference and measured data can be analysed. (Menu item **View | Lateral deformation / Height deformation** or button). In the following example, the lateral deviation is greatest in the top left corner and the height deviation is greatest in the bottom left corner. The difference depending on direction of both height images are displayed on the bottom left of the screen.

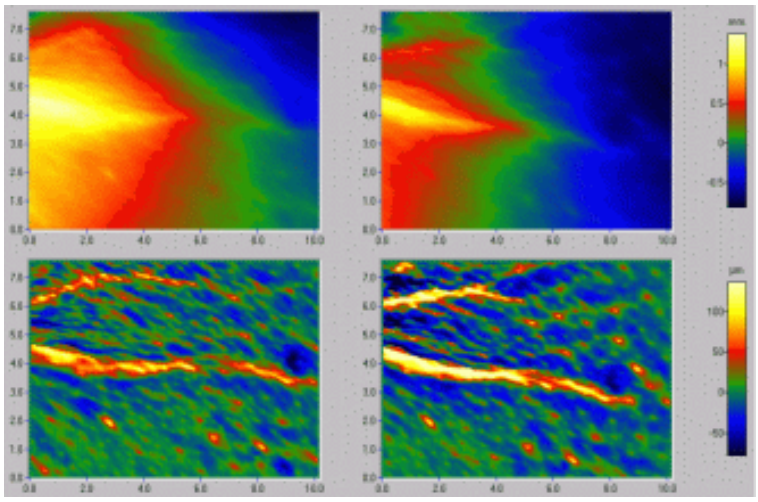


Img. 14.13: Height difference (top left), Measuring data (top right), difference depending on direction (bottom left), lateral deformation (bottom right)

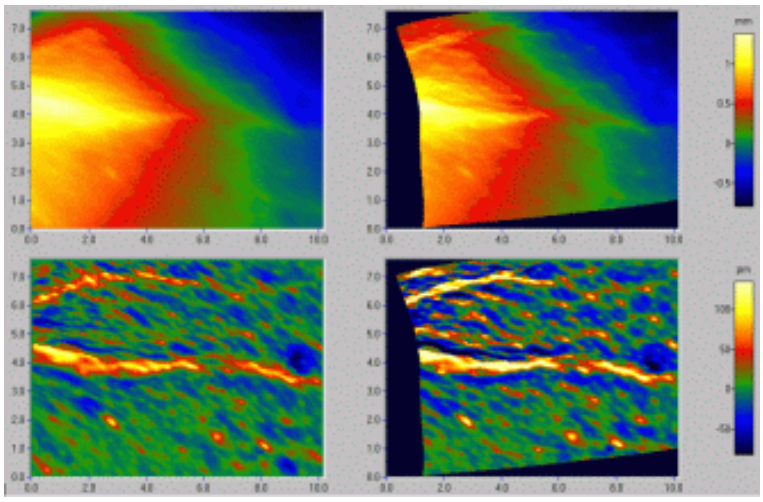
14.3.3. Height Differences

The determination of height differences (Menu item **View | Difference** or button after selecting the original-, structure- or course- height image) is one of the most important jobs is the comparison of measuring samples.

Corresponding to treatment, a smaller structure height can be seen in the following figure (fig. 14.15). Due to deviations in position during the measuring, a matching / alignment is not possible. Through automatic alignment, the micro structure of both samples has been fitted. A deformation which probably originated from the manufacture of the replica is taken into account by the software during the alignment (for this reason in vivo is preferred over the replica method).



Img. 14.14 Reference- and Measuring data of crows feet (Replica) before the alignment



Img. 14.15 Reference- and Measuring data after the alignment

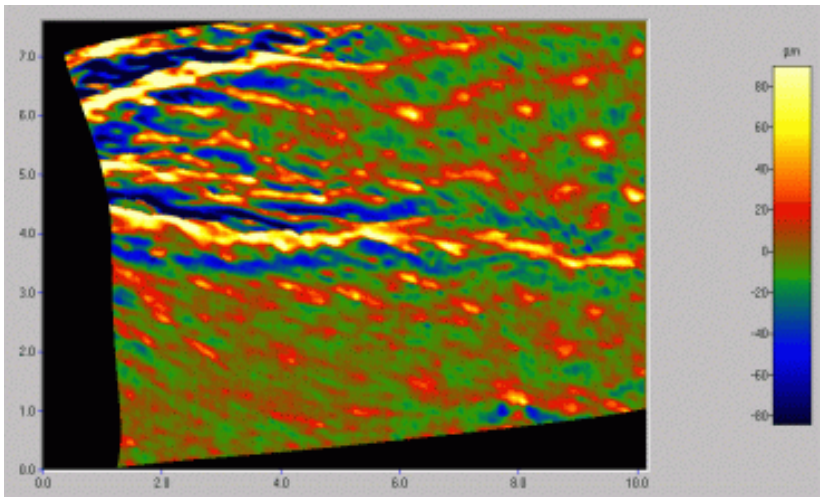


Fig. 14.16 Height difference of reference and measuring data

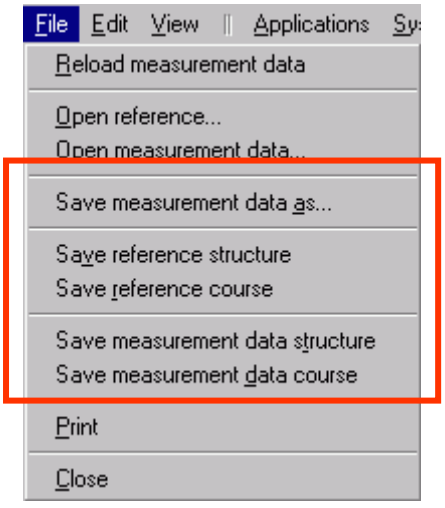
The amount of height difference allows a direct measurement of structural changes of the skin surface.

14.3.4. Structure Changes

Advanced evaluations or comparisons of structures can't be performed directly in the matching program for height pictures. For corresponding evaluations, (e.g. roughness analysis) the aligned height images should be saved and subsequently opened in the topography work area. Take into consideration while doing this, that it is beneficial during the calculations of roughness parameters and especially the treatment of height images with polynomial filters, to fill in non-overlapping areas of the measuring data with reference data. A large number of evaluations can be conducted simultaneously for many files in the data base mode. For further evaluations, it is possible to place intersecting lines or marked areas in the same position. For such evaluations, the functions " Copy, save, insert and open parameter" can be used which can be found in the topography work area.

14.4. Saving Matched Data

In the menu **File**, various possibilities of file saving are available (s. Fig. 14.18) that are explained in detail below.



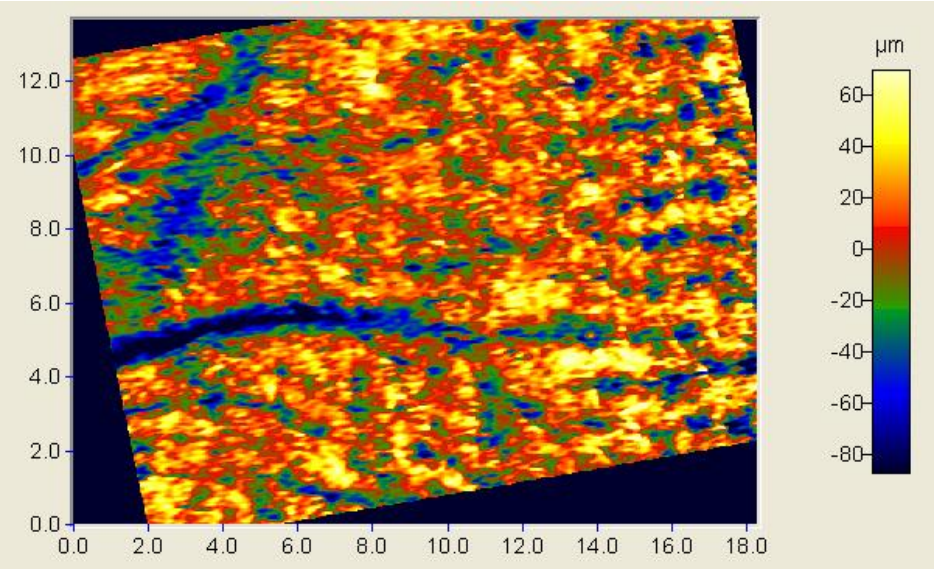
Img. 14.17 Possibilities for data saving

- **Save measurement data as...**

Makes it possible to save matched files under a new name or in a new directory.

- **Save Reference- / Measuring data structure**

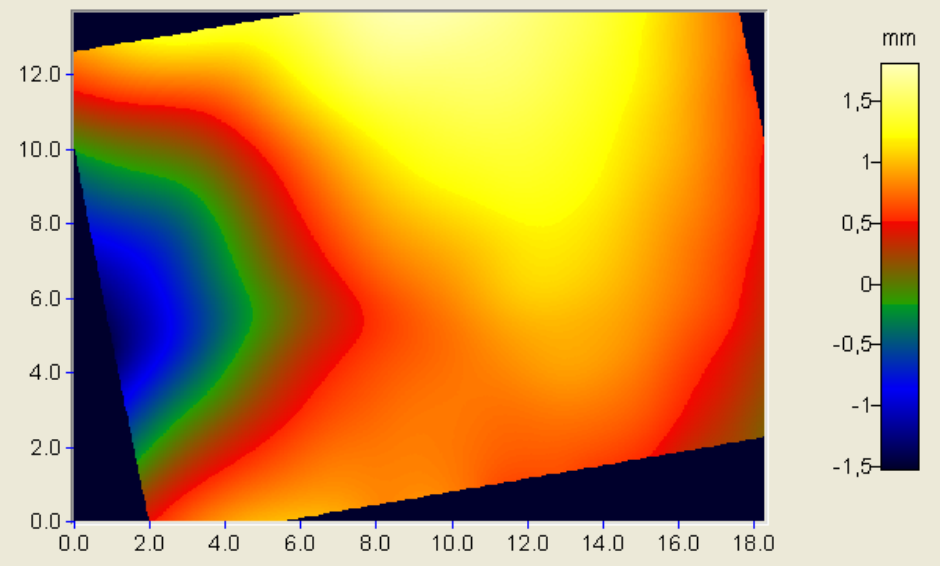
This option makes it possible to save only the roughness (Micro structure) of the reference or measuring data under a new name or in a new directory.



Img. 14.18 Structure height image

- **Save reference- / measuring data course**

This option makes it possible to save only the waviness (macro structure) of the reference or measuring data under a new name or in a new directory.



Img. 14.19: Course- height image

Further information regarding the use of the functions can be found in the chapter
“Brief description of the program function in the measuring, control and evaluation software”

15 Volunteer

15.1. Purpose of the module

The newly developed SQL-based test person database in the Primos software enables an easy and efficient administration of your measurement surveys. This database uses the Open Source software Postgres. The Postgres software must be installed on the PC use the test person database. For an update of Primos with this database, the installation pack of the Postgres 8.3 software is also delivered. In the measurement module, the following items can be selected or newly inserted before measurement: survey, test person, product, area and information. The next measurement time T is shown automatically. After measurement, the result files are saved in the folder of the survey with a systematic name according to the previously given information.
The saved files can be opened with selected properties in the standard database module. The administration of the test person database is also found in the standard database module. There, the content of the database can be shown completely or with selected properties, distinct datasets can be edited or deleted and the destination directory can be changed.

15.2. Installation notes

For installation of the Postgres 8.3 software, administrator rights are needed.
Please start the "SETUP.bat"-file. Please type "postgres" for username and password each time it is requested. (Otherwise the test person database will not run via Primos!) Ignore messages that the password might be too easy. You don't need to select any further packages from the list for installation. After successful installation don't install further Postgres packages (Stack Builder). Restart your computer.

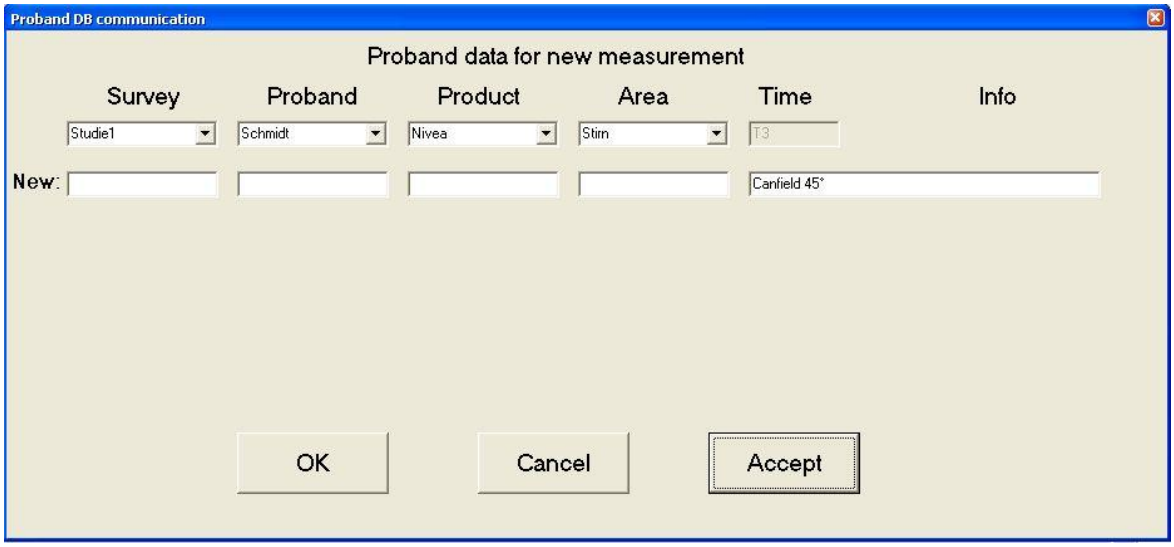
Note: The file system has to be NTFS.

At the first start of the new Primos software after Postgres installation, an empty test person database will be generated automatically. The Postgres database server will be started automatically at each opening of the Primos software, if not yet running. The database server is also stopped automatically upon quitting Primos, if no other Primos instance is running.

15.3. Inserting test person data in the measurement module

Please make sure that the test person database is activated. Therefore open the database . **File | Test person (proband) database administration | Use proband database** must be checked (see Fig. 3 below). At the start of the measurement module, the user is requested for using the test person database for measurement. If “yes” is selected, the measurement will be assisted by the test person database. Please press the button “Info proband” to insert the data of the current test person before measurement. In the shown dialog you can select data contained in the database or edit new data. The following data are needed for a new dataset: survey, proband, product, area and optional information. After selecting a survey, only the data contained in this survey are shown in the selection boxes. After pressing “Accept” the current measurement time is shown and also, if edited before, the information e.g. about the previously used hardware settings. If new data is edited for at least one column, the current measurement time is T0. Otherwise T is increased automatically. Leaving the dialog with “OK” enables the single and series measurement functions. If the current measurement time is later than T0, opening the reference camera file (*.kam) for overlay is done automatically without dialog. At single measurement the files will be saved by pressing the “Save”-button without dialog. The files are saved in the folder of the survey with a systematic name according to the previously given information. Only then, the new dataset is inserted into the database including the saved file names. For a series measurement, the files and the new dataset including all file names are saved automatically and the files are opened into

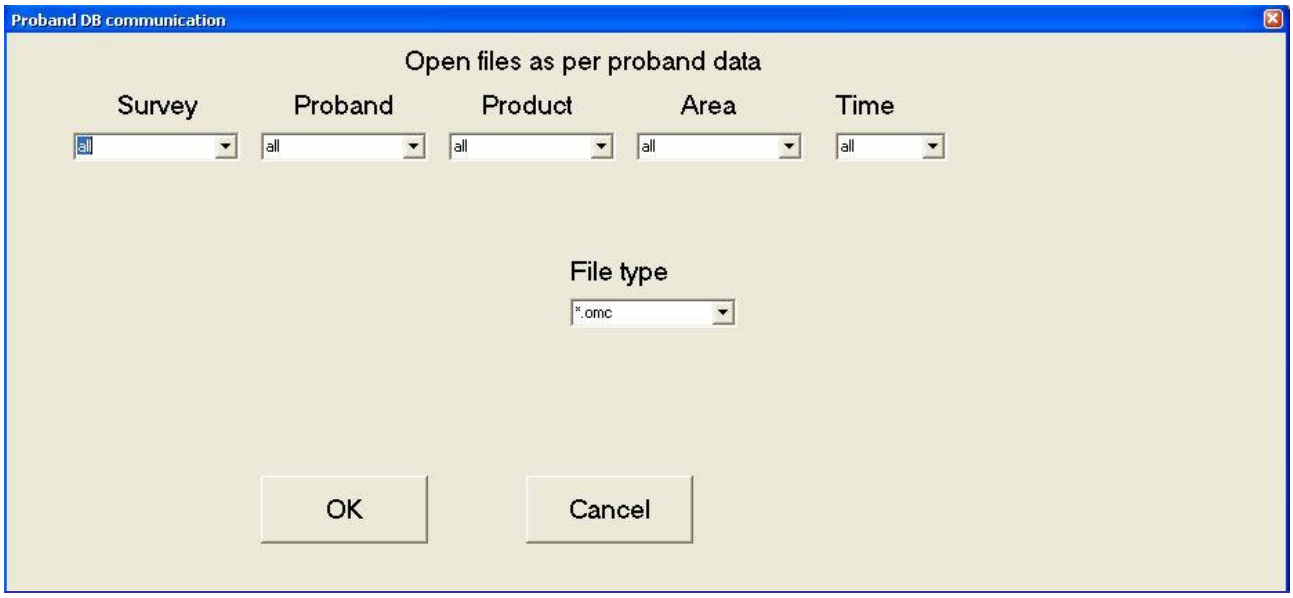
the database module. After saving a measurement (manually or automatically), the test person information for a new measurement must be edited via “Info proband” again, to perform a new measurement.



Img. 15.1: Dialog for creating a new dataset with proband data

15.4. Opening files in the database module using test person data

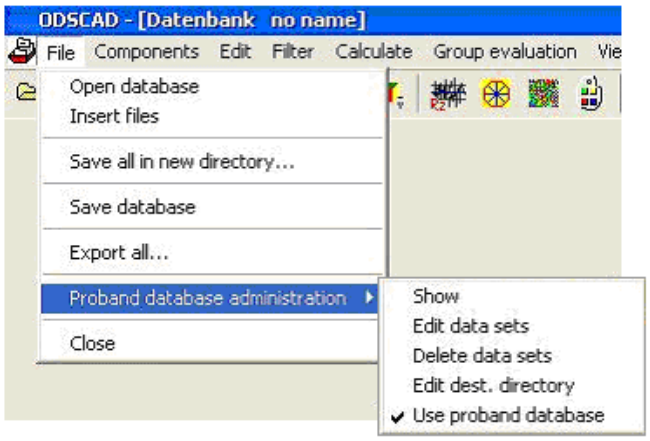
If you want to open measured files via the database module, you will be requested for using the test person database. Selecting “No” means to open the files conventionally by the file open dialog. Otherwise the database dialog is shown to select the properties of the proband data you want to open. E.g. you can open all files of survey “Survey1” or test person “Smith”. After selecting a survey, only the data contained in this survey are shown in the selection boxes. The standard choice is “all” for each column and will open every files. Also you can select the file type to open (*.omc, *.kam or both).



Img. 15.2: Dialog for opening files with selected test person data

15.5. Database administration

The database administration is accessible in the database module via "**File | Proband database administration**".



I

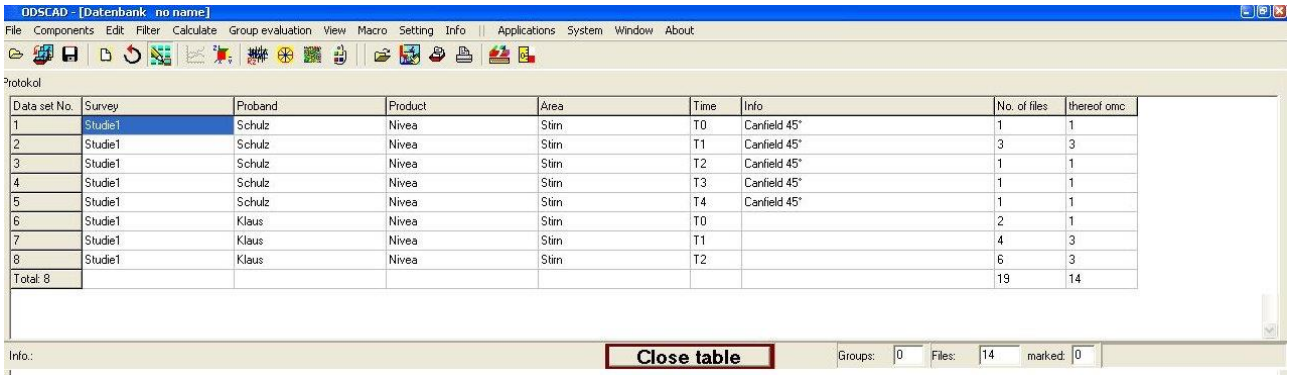
Img. 15.3: Menu in the database module with test person administration

There, the content of the database can be shown completely or with selected properties, distinct datasets can be edited or deleted and the destination directory can be changed.

Additionally to the selection of properties of datasets, a single dataset can be addressed via the number of the dataset. This number is given in the first column when showing the database content on screen. For each shown dataset the number of contained files and omc-files are given, also the number of datasets and the total number of files / omc-files of the shown datasets.

Img. 15.4: Select the properties of proband data to be shown

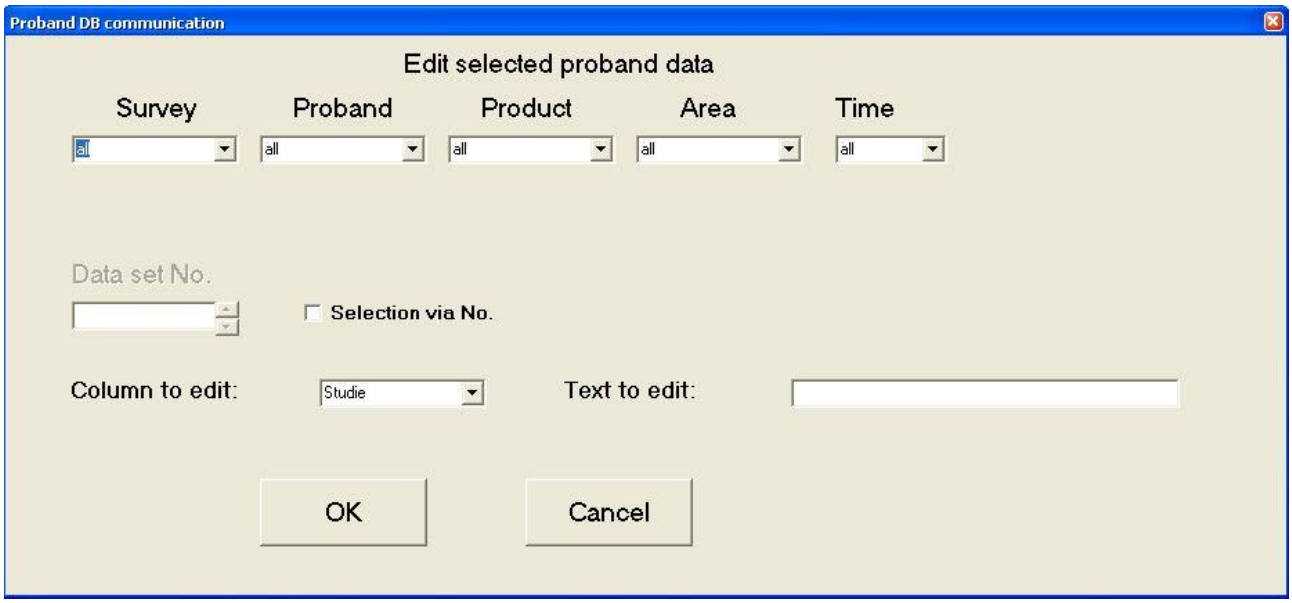
After selecting a survey, only the data contained in this survey are shown in the selection boxes.



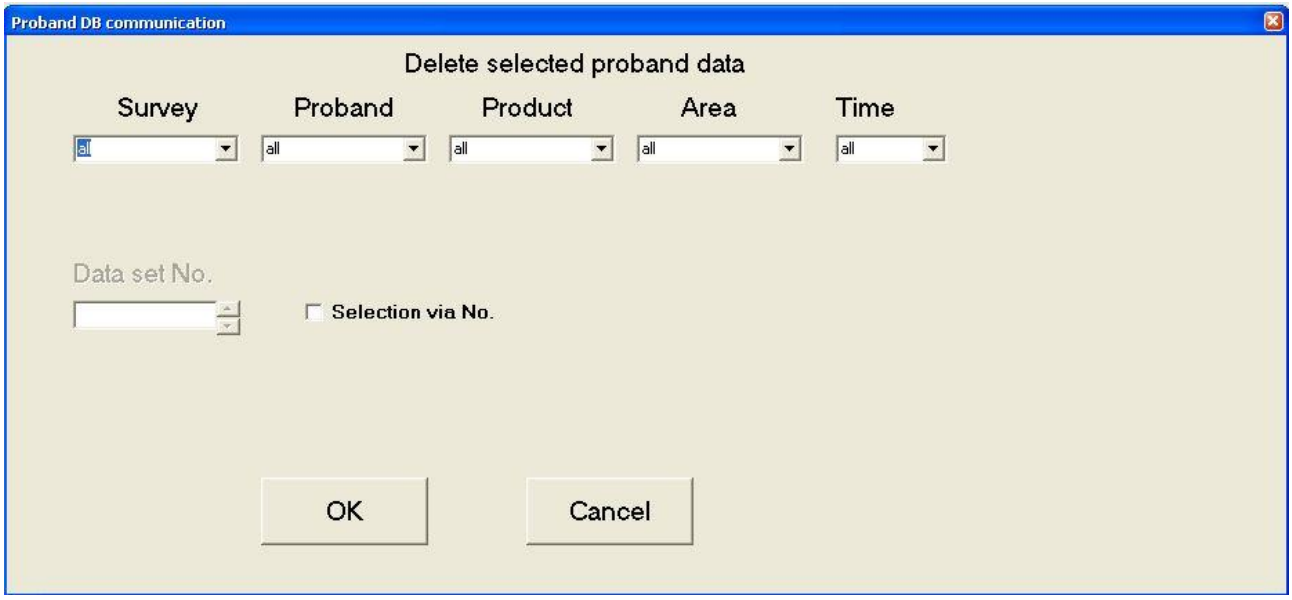
Data set No.	Survey	Proband	Product	Area	Time	Info	No. of files	thereof omc
1	Studie1	Schulz	Nivea	Stirn	T0	Canfield 45°	1	1
2	Studie1	Schulz	Nivea	Stirn	T1	Canfield 45°	3	3
3	Studie1	Schulz	Nivea	Stirn	T2	Canfield 45°	1	1
4	Studie1	Schulz	Nivea	Stirn	T3	Canfield 45°	1	1
5	Studie1	Schulz	Nivea	Stirn	T4	Canfield 45°	1	1
6	Studie1	Klaus	Nivea	Stirn	T0		2	1
7	Studie1	Klaus	Nivea	Stirn	T1		4	3
8	Studie1	Klaus	Nivea	Stirn	T2		6	3
Total: 8							19	14

Img. 15.5 Content of the database shown on screen

For editing distinct datasets, the column to be edited is selected and the new text is inserted by the user.



Img. 15.6: Editing the content of a column of distinct datasets



Img. 15.7: Deleting distinct datasets

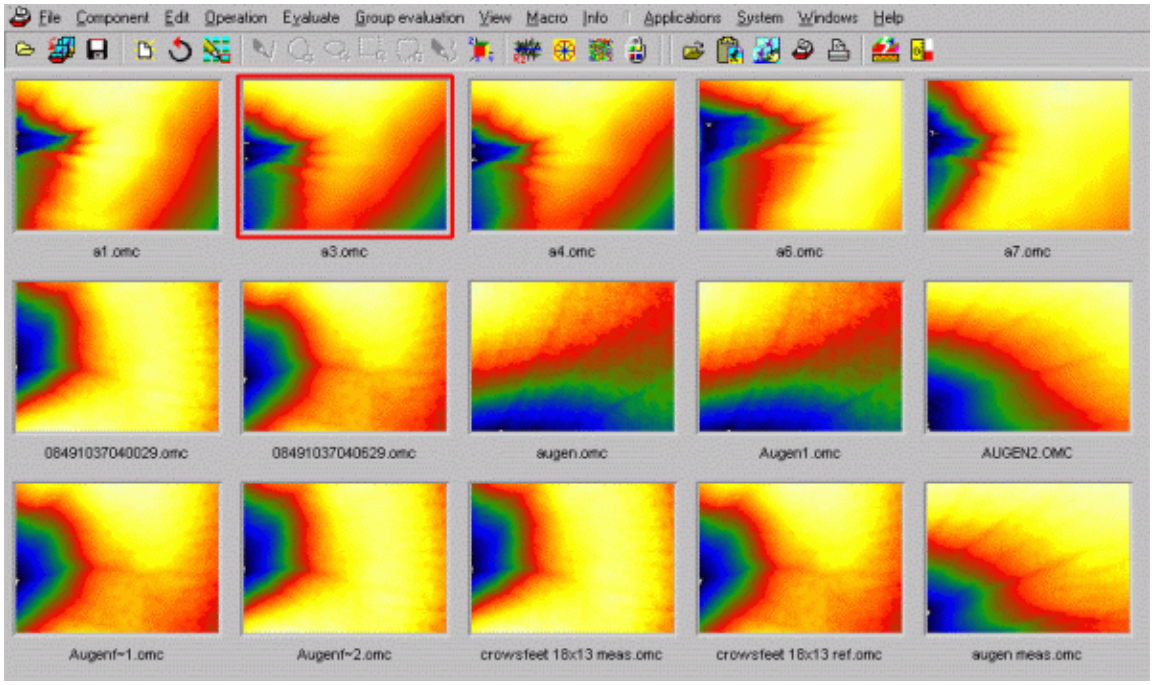
Note: If datasets are edited or deleted, the related files are NOT renamed or deleted! But the relation between the edited datasets and the files is still given by the file names contained in the datasets.

Img. 15.8: Change the destination directory

16 Analysis Database

16.1. Opening and Saving of a Database

Databases are saved as *.**bnk**-Files. In the database, file name, position on the hard drive and overview pictures of the height images are saved. The 3D data itself is not taken over into the database. For this reason it is necessary to make sure that, after working on the height images they are saved again if the changes are to be kept. If height images are saved from the data medium, they are also no longer available in the data base (Only the overview pictures are still available).

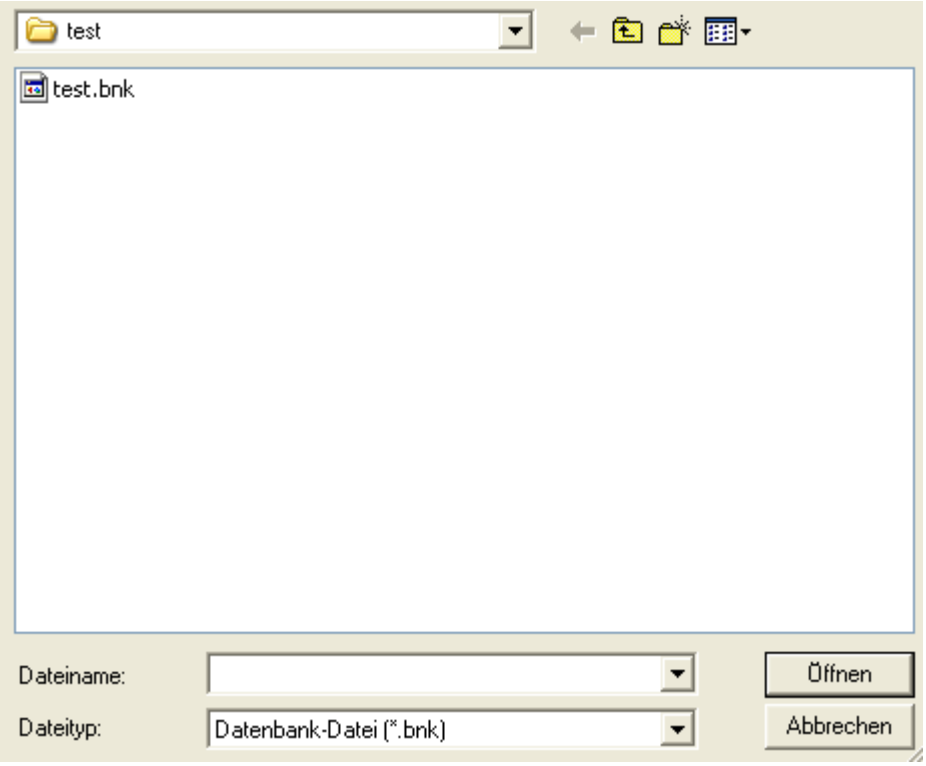


Img. 16.1 User interface “Gallery presentation of database“

Opening the database window is done through the menu item **File | Open Database** or through the button in the tool bar.

To open a database, select the menu item **File | Open database** or through the button in the tool bar.

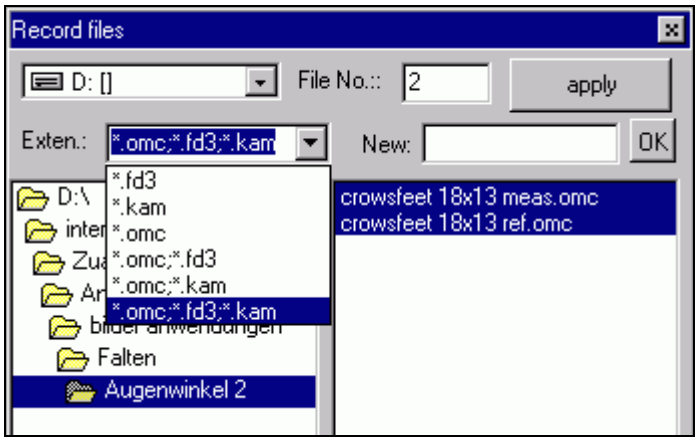
Saving the data base us done through the menu item **File | Save database** or through the button in the tool bar.



Img. 16.2 Opening of a saved database

16.2. Inserting and Saving of Height Images in the Database

To insert height images into a database, select the menu item **File | Insert file** or the button .
If the test person (proband) database is activated, a window appears where you will be asked if you want to use it. Detailed information about the test person (proband) database can be found in chapter 15. If you choose “No”, you will get to the analysis database and the window “Insert files“ opens. In the top left field, the data medium can be selected, on which the necessary data is saved. In the field below, the data filter is selected. In the directory tree, navigate to the directory that contains the measuring data. To the right, all the files in this directory are now shown that correspond to the file filter. Here you can now select one or all of the files with the cursor. Using the button **Apply**, all selected files are inserted into the database.



Img. 16.3 Inserting files into a new database.

The saving of edited height images occurs as follows:

After selecting the menu item **File | Save all in new directory**, the window „Insert files" opens (see fig. 16.3). Now, by using the text field "New", a new sub directory can be created in the directory tree. Enter a name in the text field and then confirm with **OK**. The directory is added and automatically opened. Now, activate the **Save** button. The files are saved in the new directory. **Warning!** If the **OK** button is not pressed after inserting a new directory name, then the original data is over written.

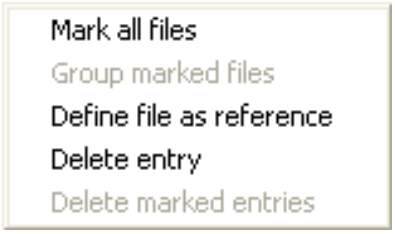
16.3. Gallery Mode

The gallery mode serves the overview display of all height images in the database. In this mode, various calculations can be performed simultaneously for several height images. For this, the overview pictures of the height images that are to be worked, are selected. Hereby, the pictures are bordered with differing colours, depending on their marking and selection status. Following boarders are used in the gallery mode:

- No boarder = the overview image is not marked and is not the currently selected
- Red boarder = the overview image is not marked, but is the currently selected
- Yellow boarder = the overview image is marked and is the currently selected
- Blue boarder = the overview image is marked but is not the currently selected.

Images can be marked by clicking the left mouse button. The current marked pictures are yellow framed, already marked pictures are blue framed and by clicking the mouse button a second time the picture is red framed which means that the picture is deselected.

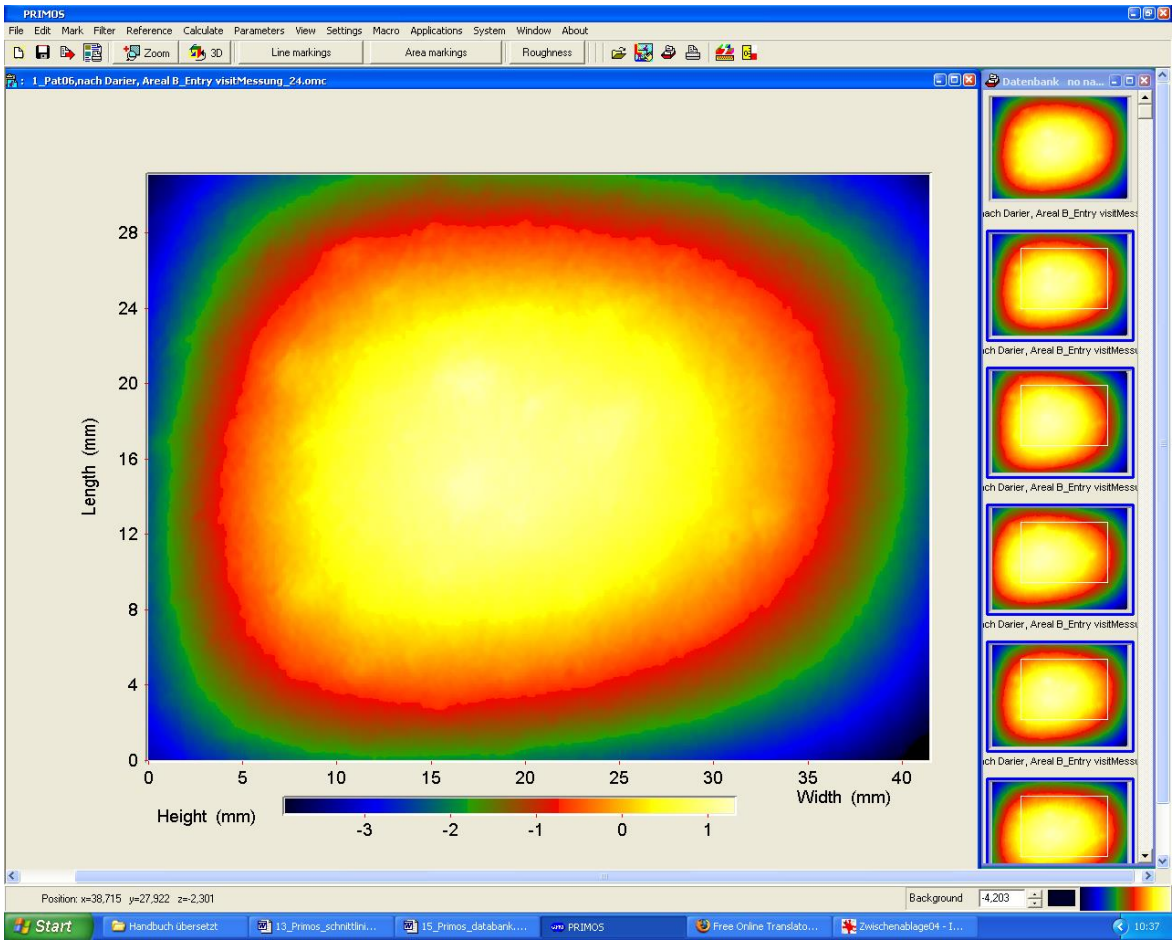
If a picture is selected with the right mouse button a context menu appears where you can select all or deselect all the pictures.



Img. 16.4 context menu

16.3.1. Marking of Areas or, respectively, Lines

To mark a line or area in several height images at the same place, the area or line is drawn into one height image and is then copied into the rest. To do this, click on an overview image and by using the menu item **Applications | Take up height picture into work area**, respectively, double clicking the left mouse button in the overview picture in the work area. There you now draw the marking (see chapter “Evaluation of 3D data“). With the menu item **Edit | Copy parameter** the current marking is copied into the clip board. Return to the database window and insert the marking using the menu item **Component | Insert parameter**. By clicking on the corresponding marking icon, or selection in the menu **View**, the corresponding marking appears in the blue bordered height images.



Img. 16.5 Transfer of markings out of a single picture into the same position on all pictures in the database

16.4. Automatic Evaluation

Automatic evaluations and calculations are always undertaken in the database on the marked height images. How the images are marked for evaluation is explained in the section “Gallery mode“. Following, the functions available in the sub-menu of the database window are explained. Further information regarding the usage of these functions can also be found in the chapter “Brief description of the program function in the measuring, control and evaluation software“.

16.4.1. Functions in the Menu “Components“

Button	Function
Mark Single Entry.	If this function is activated, (menu item is checked), then a height image is marked or, respectively, unmarked with a click on this.
Mark all Entries	All height images in the database are marked.
Mark no Entries	No height image is selected = all markings of height images are undone.

Default file groups	The files will be grouped with pre-settings. The first reference image receives the name 1 R and the following images are called 1 M, etc.
Form new file groups	Through this function, the data grouping is adjusted. For this, it is necessary that the names of the files to be matched have the same word stem and a variable number.
Switch position between 2 entries	If this function is enabled (mark set in front of menu point) then by a click of the left mouse button in a height picture and continued holding of the button, the height picture can be moved onto another height picture. If you let go of the mouse button, then the two height images switch positions.
Delete marked entries	By a click on this menu item, all marked entries will be deleted.
Sort entries by name forward	By a click on this menu item, the height pictures of database will be sorted by name in alphabetic order.
Sort entries by name backward	By a click on this menu item, the height pictures of database will be sorted by name in reverse alphabetic order.
Sort entries by time forward	By a click on this menu item, the height pictures of database will be sorted by time of creation, forward (oldest file located on first position).
Sort entries by time backward	By a click on this menu item, the height pictures of database will be sorted by time of creation, backward (newest file on first position).
Open parameters	By clicking on this menu item, marking file saved markings can be inserted all selected database files.
Insert parameters	By clicking on this menu item, markings whose parameters were previously copied into the clipboard, are inserted into all selected database files. (function “Copy parameter“ – see chapter “Evaluation of 3D data) If no parameters were copied into the clipboard, then this function does nothing.

16.4.2. Functions in the menu „Edit“

Button	**Function**
Undo	By a click on this menu item, the last operation of data evaluation (Filtering, alignment, etc.) is undone.
Draw new	All markings are deleted from the height pictures.

Cut	The marked area(s) of the height images are cut out.
Beschneiden	The area(s) around markings in the height images will be cut out.
Inverse picture	Inverts the marked height images.
Vertikal spiegeln	The marked height images are mirrored vertically.
Flip horizontal	The marked height images are mirrored horizontally.
90° left	Turns the marked height images 90° to the left.
90° right	Turns the marked height images 90° to the right.
180° turn	Turns the marked height images 180°.
Turn…	Turns the marked height images any selected angle.
New scaling	A window opens to change the scaling of the marked height images.
New resolution	A window opens to change the resolution of marked height images.
Determine max. rectangle and crop	The maximum available part in all images will be identified and cut out
Crop rectangle	The marked part of the image will be cut out

16.4.3. Functions is the menu “Filter“

Button	**Function**
Align	Aligning the marked height images to their average plane or to marked areas of height picture
Polynomial-filter	Removing geometric form deviations from selected height images corresponding to the selected class of polynomial
Remove invalid	Assigning an adjacent height value in case of absence of own height value for the measuring point of previously selected height images.
Remove hairs	The removal of hairs from the skin surface measuring data of a previously selected height image.
Gaussian filter	Use of a Gaussian filter on the previously selected height images.
Median filter	Use of a median filter on the previously selected height images.

Average filter	Use of an average filter on the previously selected height images.
Robust high-pass filter	Removal of the geometric form in the selected height images.
Fourier Filter	Using a Fourier filter on the height image to determine or filter the waviness of the structure of the skin = Press button

16.4.4. Functions in the menu “Calculate“

The determined measuring values are displayed under the relevant height image and can also be displayed in a table over the menu item **View | Measurement data**. Using the button **Copy**, in the “measurement data“ window, the table can be copied into the Windows-clipboard and from there, copied into other programs for further processing. With the button **Save**, the values of the table can be saved in a file.

Menu Item	**Function**
Surface size flat	Calculation of the „stretched“ area of the height image respectively the marked areas of it = click button
Surface size curved	Calculation of the area within the waviness of the whole height image or the marked areas = click button
Surface minimum/maximum	Detection of the value of the highest and deepest measuring point in the 3D image or the marked areas = click button

Lump-analysis	By a click on this menu, lumps (knots) on the 3D skin surface are automatically detected and their geometric parameters will be determined. These are then displayed in the in a table window (s. Fig. 27) - x, y = position of lump - volume, area = volume and area of lump - H(max) = highest point of lump By use of the button **Copy** the table can be copied via the clipboard to other programs and the data then can be processed further in these programs. If one row of the table is selected, then only that row will be copied. The function is only qualified for lumps that are small in comparison to the measuring area.
Volume on under reference plane	Calculation of the volume of the height profile (or a marked part of it) beneath a reference plane.
Volume on upper reference plane	Calculation of the volume of the height profile (or a marked part of it) above a reference plane.
Offset to Reference plane	Defining the measuring plane or measuring height for the further volume calculation. The plain is re-determined and included in the calculation as a new plane.

16.4.5. Context Menu in the Menu “Group evaluation”

Button	**Function**
Defining line roughness	Defining the parameters for the calculation of the line roughness parameters for previously selected height images of skin.
Defining surface roughness	Defining the parameters for the calculation of the surface roughness parameters of previously selected height images of skin
Defining star roughness	Defining the parameters for the calculation of the star roughness parameters of previously selected height images of skin

Start evaluation	Starting the group evaluation (Roughness calculation corresponding to previously defined calculation parameters or matching) for previously selected height images of skin.
Stop evaluation	Stops the group evaluation
Start elastic matching without filling	Conducting the elastic 3D matching for previously selected and corresponding to pt. 6 of this chapter grouped height images. Data gaps in the height image after the matching are filled with reference data.

16.4.6. Menu “View“

Menu item	**Function**
Line roughness	Display of the line roughness parameters
Surface roughness	Display of the surface roughness parameters
Star roughness	Display of the star roughness parameters
Lump parameters	Deactivated
Measuring data	Deactivated
Lines	Display of the line markings of the height images
Circles	Display of the circle markings of the height images
Ellipses	Display of the ellipses markings in the height images
Rectangle	Display of the rectangle markings of the height images
Polygon	Display of the polygon markings of the height images.
Free hand lines	Display of the free hand line markings of the height images.
Display cross section	Display of the cross section
Thumbnails	Setting of the gallery mode
Automatic scaling for all pictures	Automatic scaling of all height images in the gallery mode.

Menu item	Function
Automatic scaling for the entire database	Automatic scaling of all height images in the gallery mode
Automatic scaling for each group	Automatisch skalieren jede Gruppe von Höhenbildern im Galeriemodus

16.4.7. Menu “Macro“

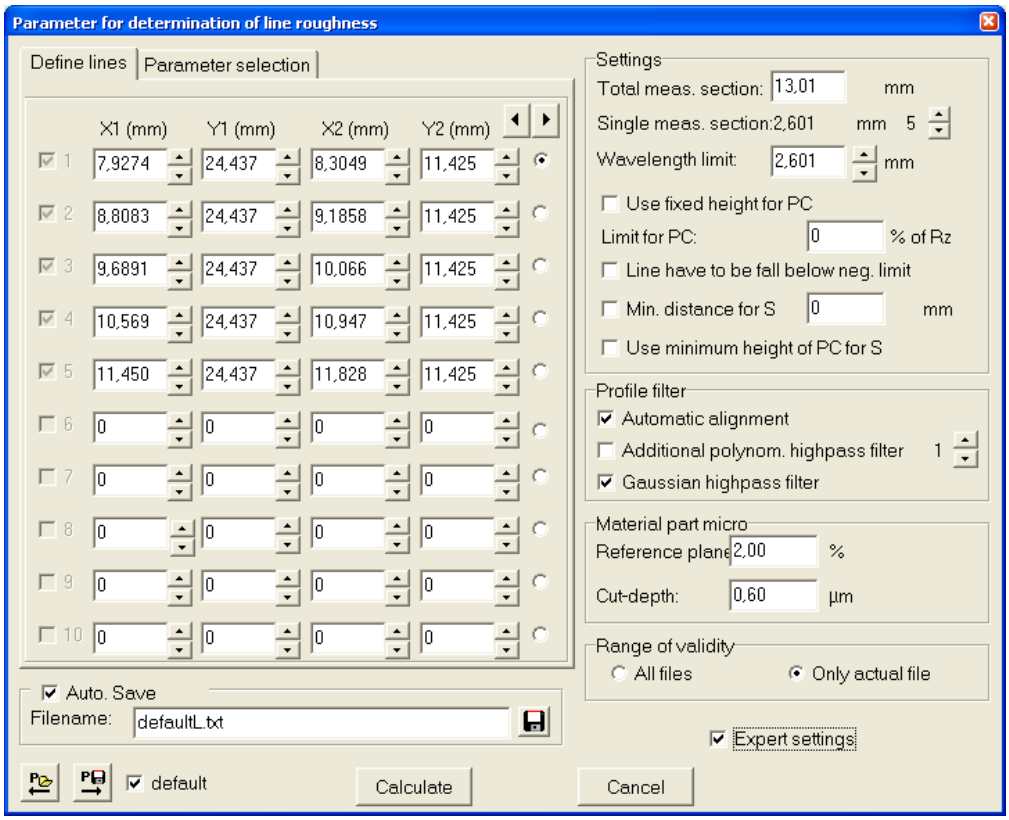
In this menu, a macro can be run. Macros contain a number of processing Steps. These processing steps are used on all selected height images of the database. Macros can be created in the work area. Information regarding the creation of macros can be found in chapter 11 “Macro functions”.

16.5. Roughness Calculations

The menu item “Group evaluation” serves the roughness calculation. Firstly, the parameters of the roughness calculations must be defined. Details regarding the parameters for the roughness calculation are explained in chapter 10 “Roughness parameters“. Mark the selection field “Auto save” in the dialogue windows for the roughness calculation when the calculation results are to be saved in a file.

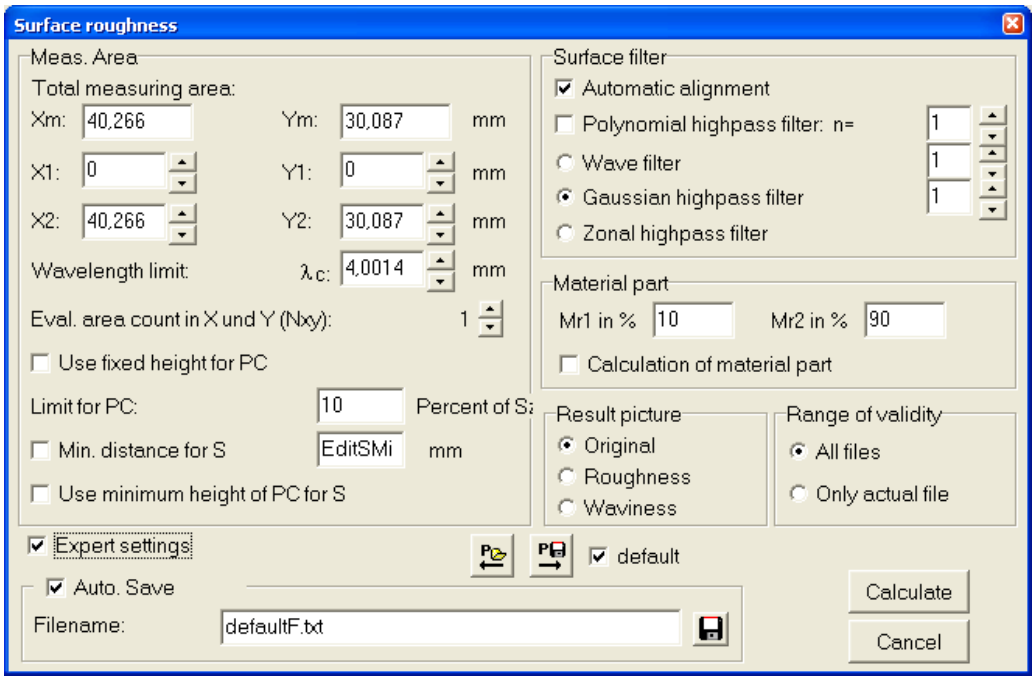
After clicking on the button , a window opens in which the name and path of the file is designated for the saving of calculation results. In the field “Range of validity”, it is designated whether all marked files, or only the current one are evaluated.

Following this, the automatic evaluation can be conducted over the menu item **Group evaluation | Start evaluation**. If the automatic saving is activates, then the measurement values can be seen into the relevant file. The menu item **View | Line-** / **Star- / area roughness**, the measurement values for the active height image (red boarder) are displayed in a window.



Img. 16.6 Dialogue window “Define Line roughness“

There is the possibility to evaluate up to 50 lines. To be able to change all the settings “expert settings” must be checked.



Img. 16.7 Dialogue window “Define area roughness“

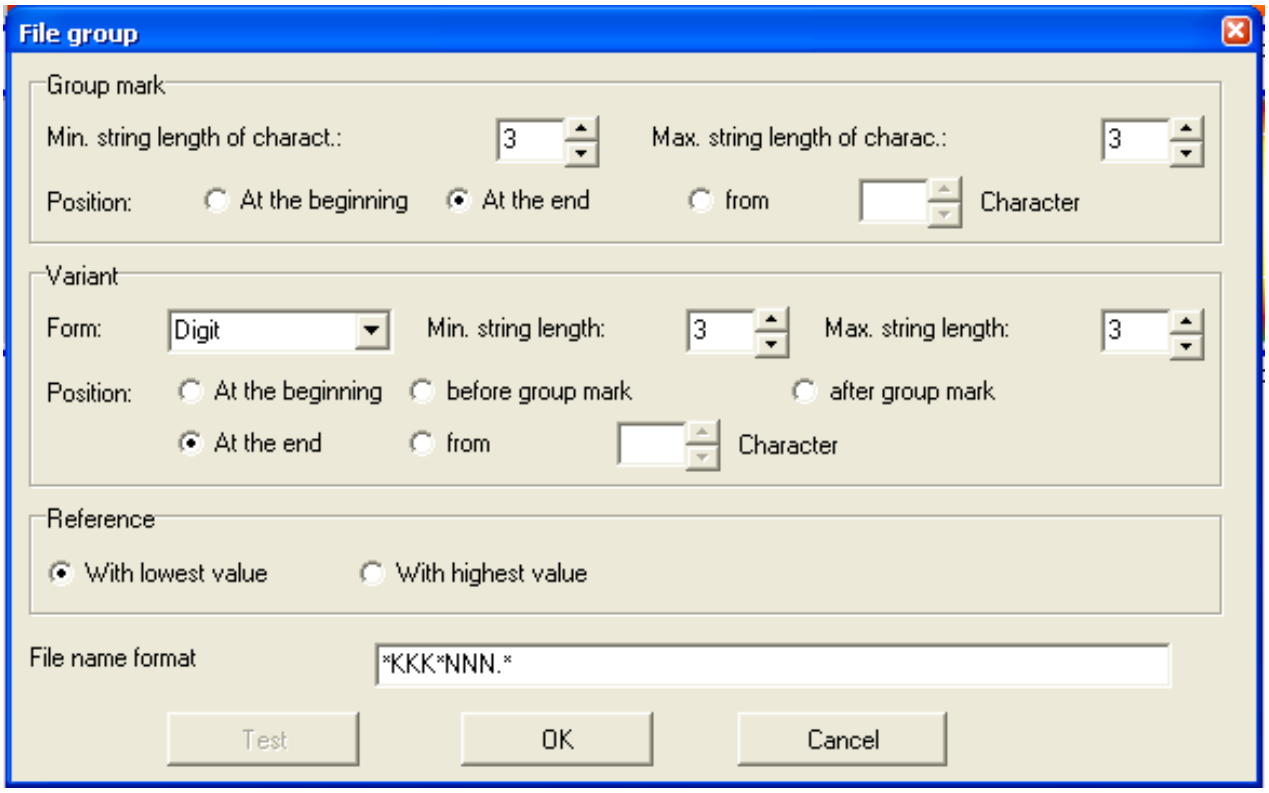
No.		1	2	3	4	5	Average	Std.-dev.	Min.	Max.
Lm	mm	13,01	13,01	13,01	13,01	13,01				
Le	mm	2,601	2,603	2,603	2,603	2,603				
Lc	mm	2,601	2,603	2,603	2,603	2,603				
X1	mm	126	8,808	9,689	10,56	11,45				
Y1	mm	385	24,43	24,43	24,43	24,43				
X2	mm	132	9,185	10,06	10,94	11,82				
Y2	mm	180	11,42	11,42	11,42	11,42				
Rtp %	%	2,00	2,00	2,00	2,00	2,00				
Rtp c	nm	600	600	600	600	600				
Ra	µm	141,8	139,3	136,1	118,7	123,5	131,9	10,19	118,7	141,8
Rq	µm	188,6	180,1	169,2	157,7	158,6	170,9	13,44	157,7	188,6
Rmax	mm	1,443	1,331	1,145	1,096	0,949	1,193	0,195	0,949	1,443
R3z	µm	0	136,1	171,2	0	0	61,47	85,09	0	171,2
Rt	mm	1,452	1,331	1,253	1,187	1,126	1,270	0,127	1,126	1,452
Rz	µm	756,0	721,0	655,1	635,8	619,1	677,4	58,54	619,1	756,0
Rp	µm	436,0	491,9	466,8	442,0	431,7	453,7	25,29	431,7	491,9
Rpm	µm	324,4	282,6	309,5	288,1	259,5	292,8	25,03	259,5	324,4
Rv	mm	1,016	0,839	0,787	0,745	0,694	0,816	0,123	0,694	1,016
Rvm	µm	431,6	438,3	345,5	347,6	359,5	384,5	46,42	345,5	438,3
Rsk		-0,10	-0,41	0,09	0,13	0,09	-0,04	0,23	-0,41	0,13
Rku		3,17	3,28	2,86	3,74	3,15	3,24	0,32	2,86	3,74
Rsm	mm	1,405	1,683	1,085	1,692	1,301	1,433	0,259	1,085	1,692
S	µm	297,8	295,3	348,2	377,2	301,6	324,0	36,85	295,3	377,2
Rda		1,1545	0,9884	1,0575	0,9752	0,8744	1,01	0,10	0,87	1,15
Rdq		1,7961	1,4552	1,3272	1,3361	1,1938	1,42	0,23	1,19	1,80
Rla	µm	772,0	885,7	808,8	764,8	887,8	823,8	59,80	764,8	887,8
Rlq	µm	659,7	778,0	801,4	741,9	835,2	763,3	67,12	659,7	835,2
Rtpi	%	2,93	2,93	2,93	2,93	2,93	2,93	0,00	2,93	2,93
Wt	mm	4,604	4,521	3,947	3,603	3,432	4,021	0,528	3,432	4,604
PC		26	15	18	23	23	21,00	4,42	15,00	26,00

Img. 16.8 Display of the line roughness parameters

16.6. Elastic 3D Matching

A precondition for the grouping of height images is a systematic file naming. Select the menu item **Component | File group new** for the grouping of height images.

In the field “Group mark“ (Fig. 10) indicate the length and the position of the character string which is common for all height pictures of the group including the reference height picture. Following this, in the field “Variant“ indicate which character string is used for numbering of the height pictures within the group. In the field “Reference”, it is designated whether the first or the last file within the group is used as reference.



Img. 16.9 Dialogue window “File grouping“

Example:

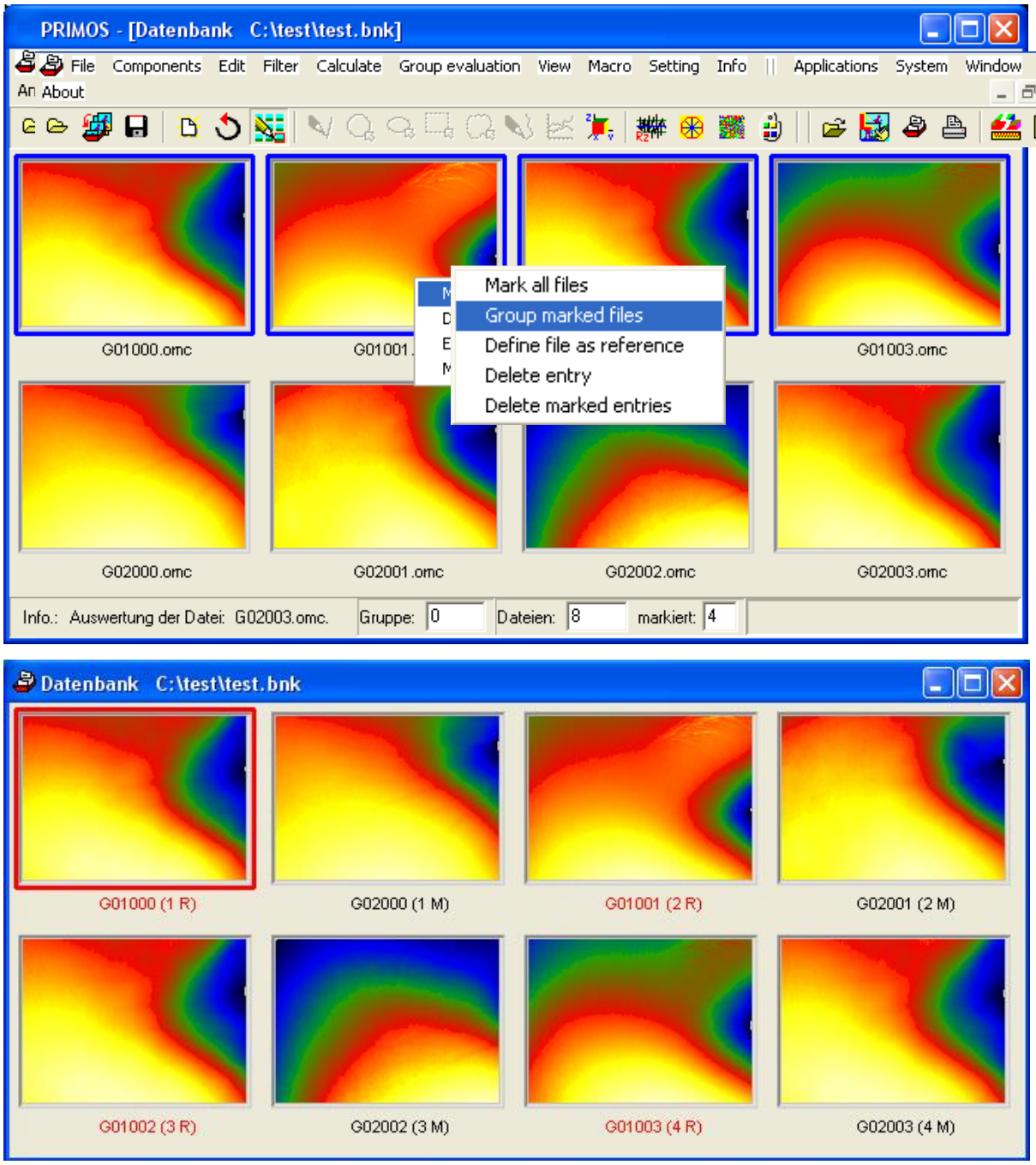
Group 1	G01000.omc (Reference)	Group 2	G02000.omc (Reference)
	G01001.omc		G02001.omc
	G01002.omc		G02002.omc
	G01003.omc		G02003.omc

After clicking the menu item **Component | Default file groups,** the grouping of the height pictures is performed. The reference image is labelled red. It is given the group number and the letter R in parenthesis. The accompanying height pictures are given in parenthesis the group number and the letter M.

The function of the file grouping has been considerably simplified. The user can mark the files to be grouped and subsequently group them. The function of the grouping can be found after a right mouse click. A file can also be made to a reference file like this. (s. Abb. 15.9)

Following this, the alignment of the measuring data to the reference data set occurs over the menu item **Group evaluation | Start elastic matching with**, respectively, **Without filling**. In the

case of matching without gap filling, points without height values (caused by shifting and turning during matching), are set to zero.



Img. 16.10 Database with 4 file groups

Further details regarding matching can be found in chapter 14 “3D matching of elastic surface structures“.

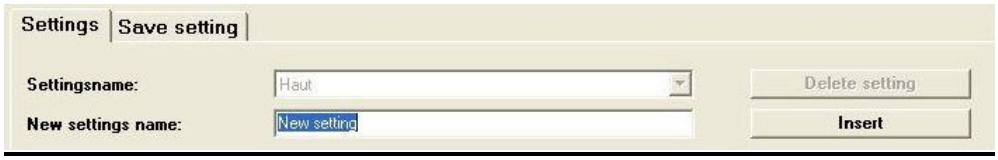
17 Wrinkle module

17.1. Purpose of the module

The newly developed wrinkles module provides a complete, statistical analysis of height pictures for skin wrinkles. On the one hand it enables a detailed analysis of single height pictures and the classification and on the other hand a summarized result for evaluation of a complete measuring series. The analyzed parameters are: The average depth of wrinkles and further its volume, area, form and length. An important feature is the possibility to select single wrinkles for evaluation. At the analysis of a measuring series in the database module only those wrinkles are used which overlap with the selected wrinkles of the reference file. As a result, the module provides text files as well as a protocol with graphics after analysis of a single file.
Note: The separate wrinkles module is not contained in the standard Primos software by LMI Technologies.

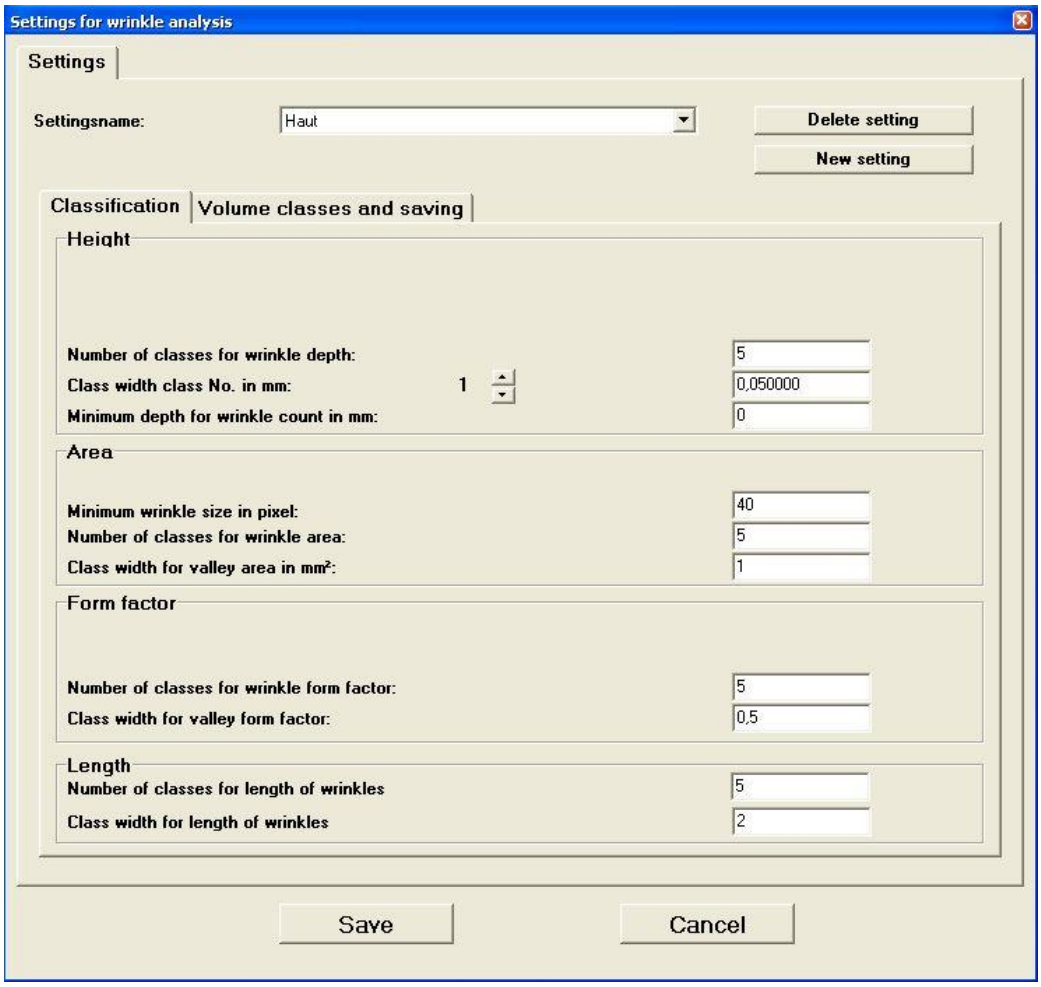
17.2 Settings

The user can create several setting schemes in the setting dialog accessible via the start window of the Primos software (press “**System | Settings for wrinkle analysis**”).

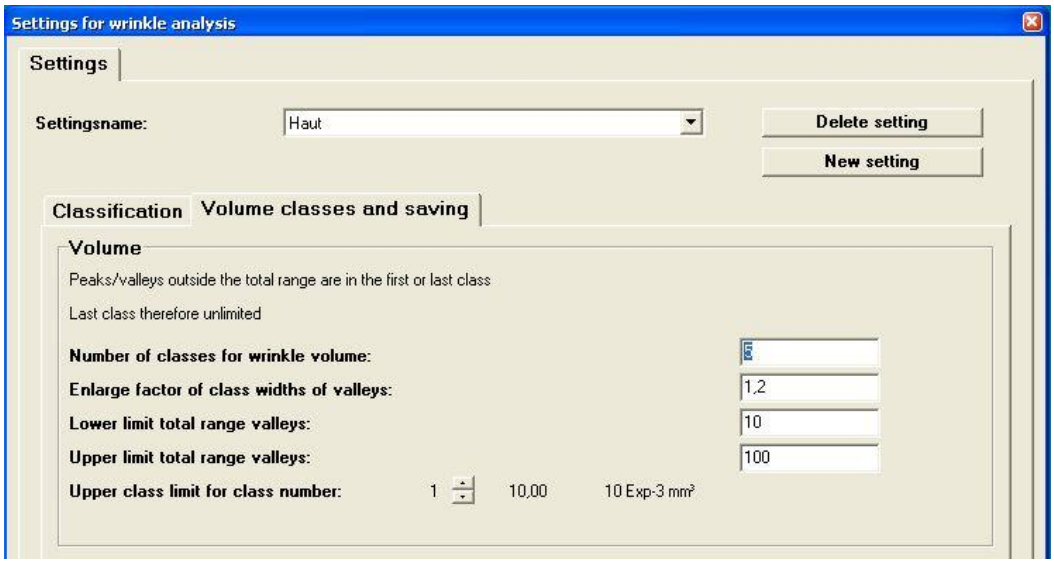


Img. 17.1: Create a new settings

The minimum depth and size of wrinkles and the classification parameters can be adjusted for personal demands. For every wrinkle parameter, the number and width of classes can be edited. For the depth, the class widths can be edited individually. Circular dimples, such as pores, with a form factor <1.03 (2:1 structure) are not considered as wrinkles. Automatically, a robust highpass filter is used for pre-filtering to flatten the height image.



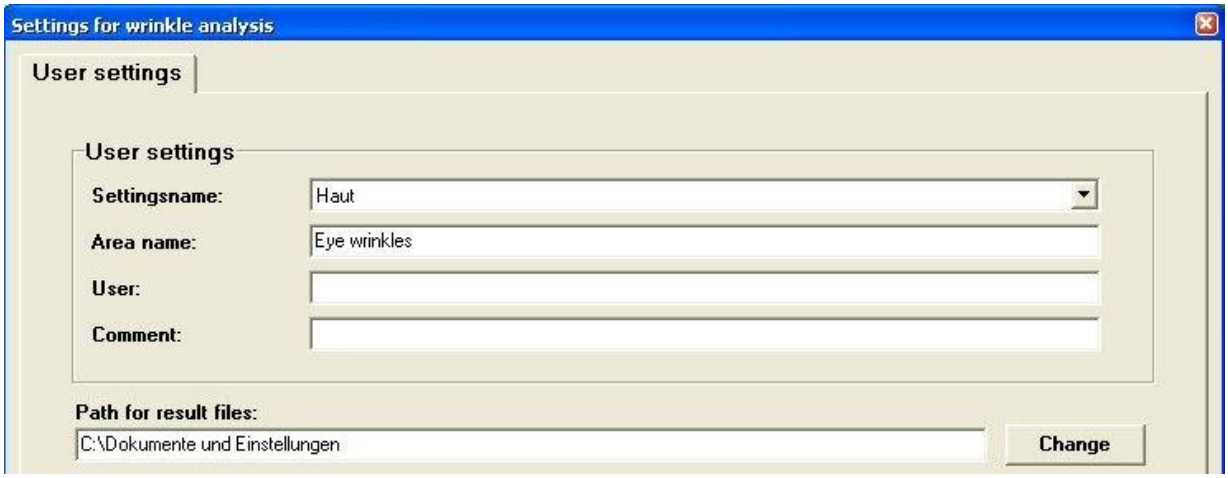
Img. 17.2: Classification and selection criterions



Img. 17.3: Classification of volume and path of saving

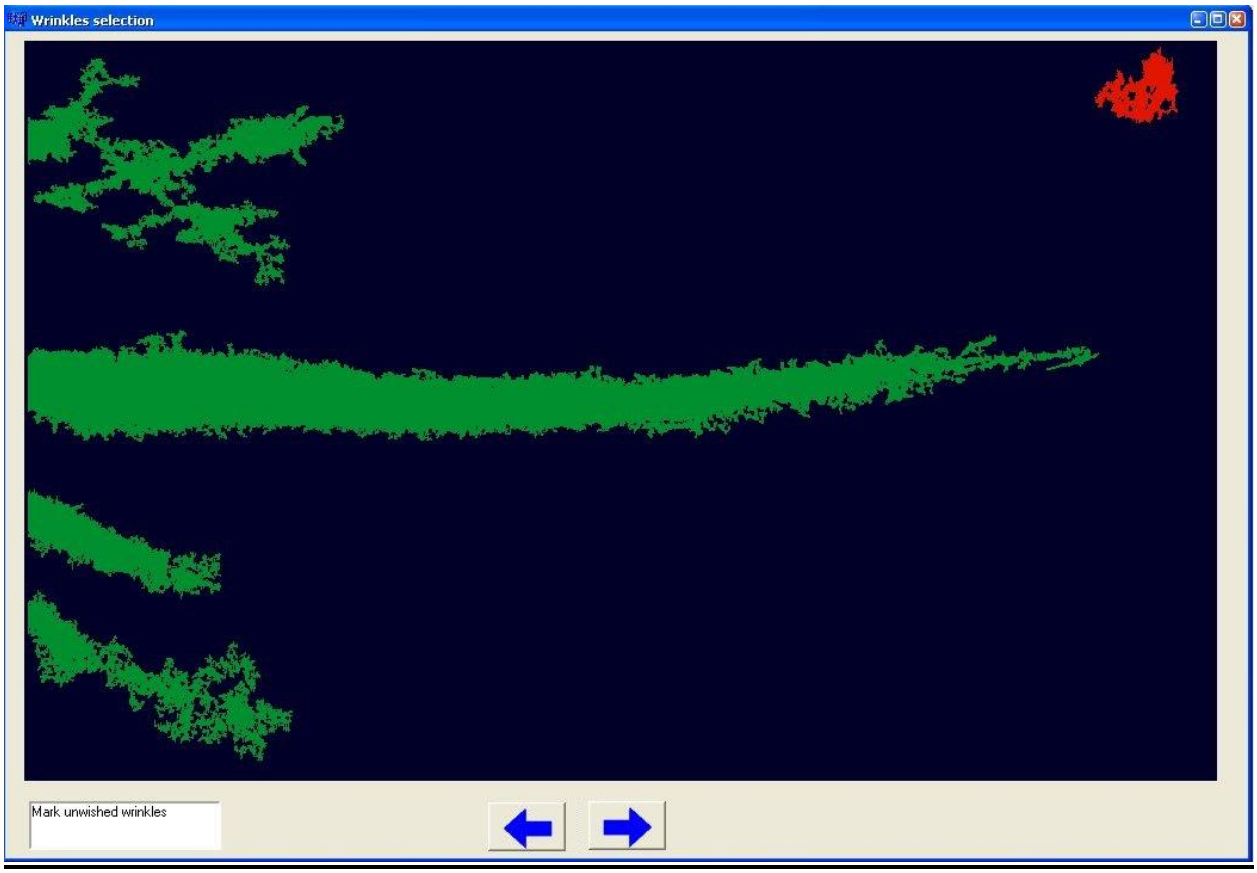
17.3 Evaluation of single files

If the height picture is matched and therefore contains invalid areas at the edge, a rectangular valid area must be selected. Start the wrinkles analysis (press “**Calculate | Wrinkles analysis**”) and select a setting name, type user information and the result path in the user settings dialog.



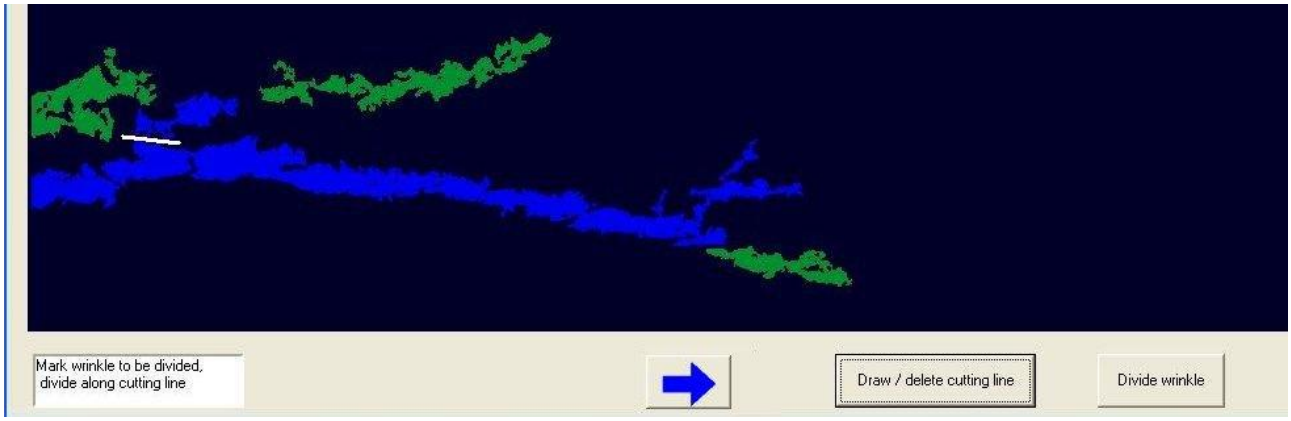
Img. 17.4: Select a user settings and result path

Next, the file is searched for wrinkles that will be shown in a dialog. Here, you can select the wrinkles you want the analyse. At the start, all wrinkles are valid (green). By clicking on a wrinkle it changes to invalid (red). With next click it becomes valid again. (For practical reasons, this step is the second step. After cutting wrinkles, you can remove unwished parts of these wrinkles.)

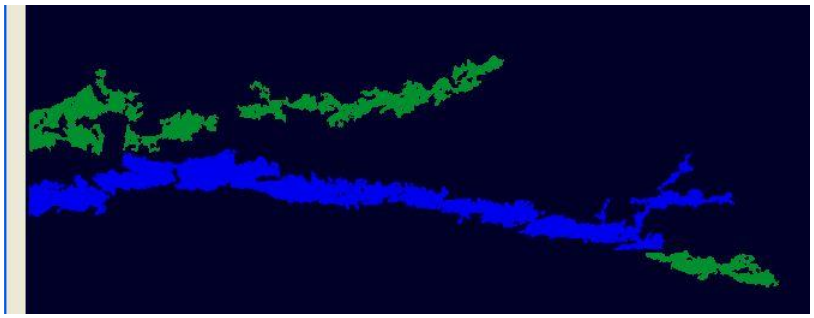


Img. 17.5: Select single wrinkles

In the first step, single wrinkles can be divided by drawing a cutting line. This is useful, if two real wrinkles are joined at a tiny place or if a real wrinkle is connected with unwished hollows. For that, mark one wrinkle and press the button “Draw / delete cutting line”. Draw the line by mouse or redraw it if not fitting. The ends of the line must not be inside a wrinkle. Pressing the button once more deletes the line and enables the selection of a new wrinkle. Divide the wrinkle per cutting line by pressing the button “Divide wrinkle”.

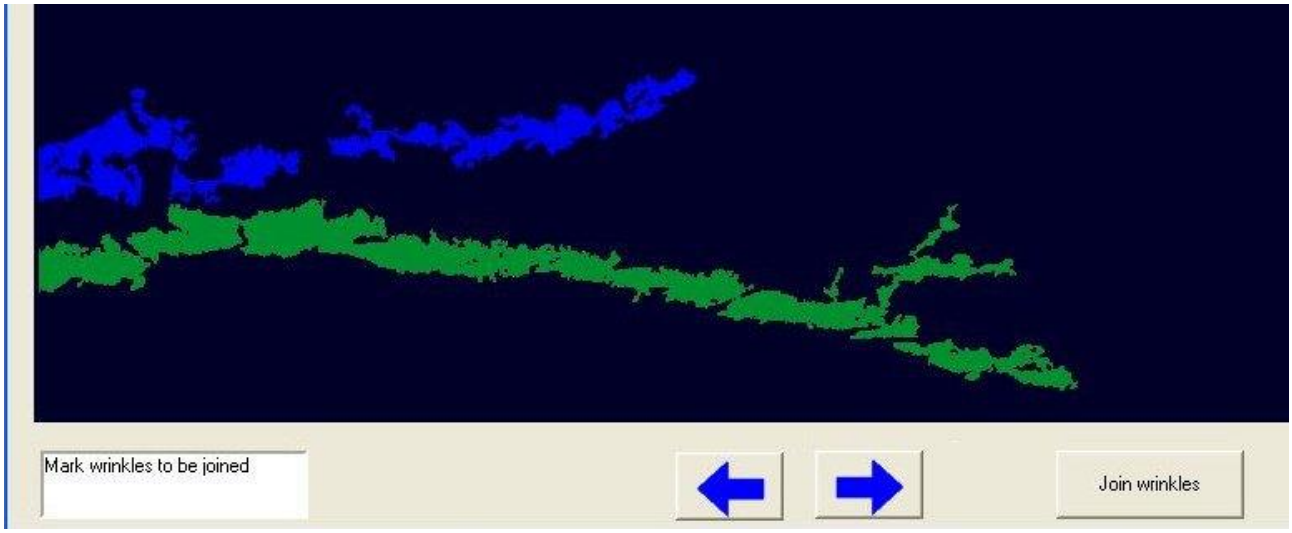


Img. 17.6: Divide a wrinkle by cutting line



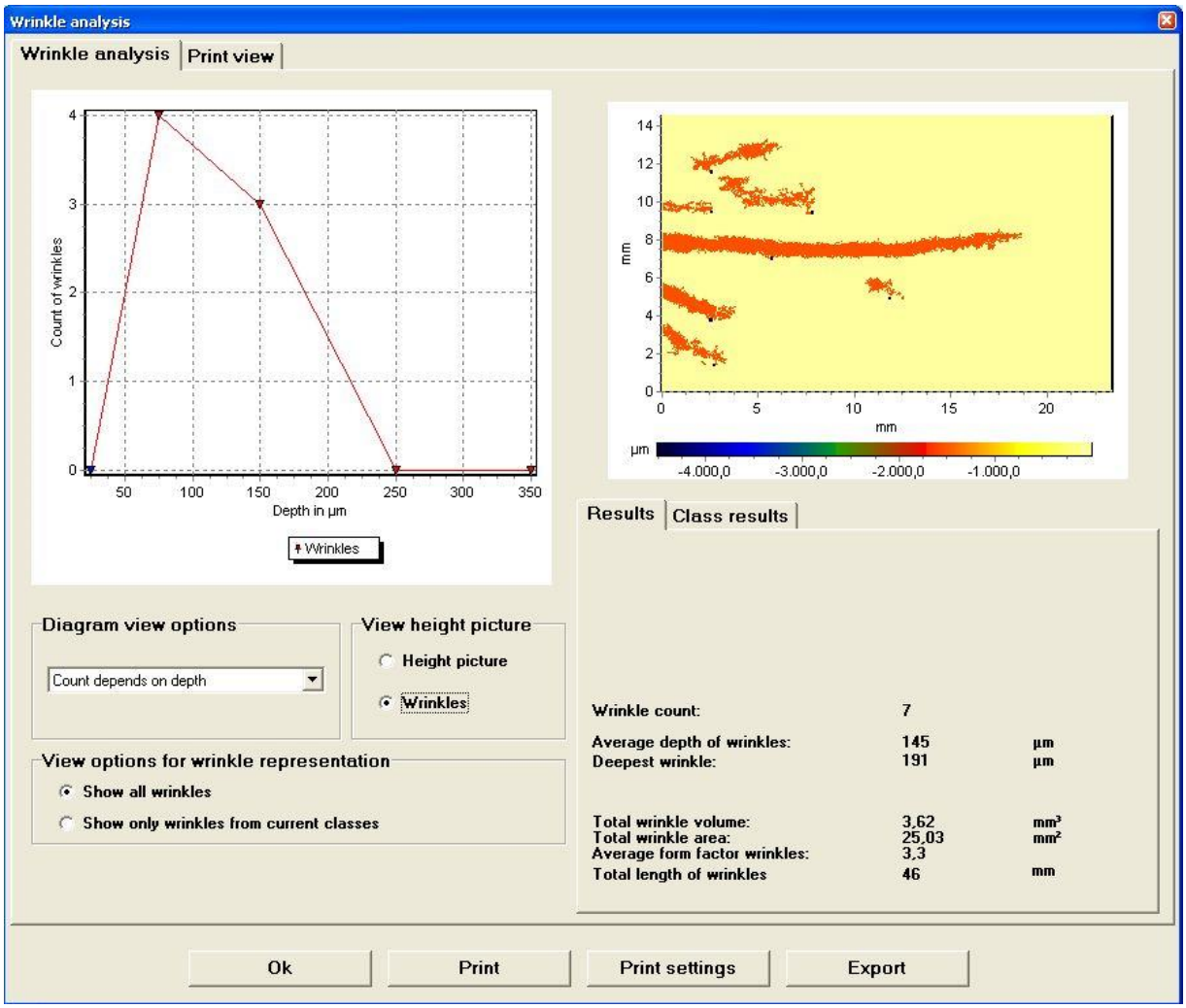
Img. 17.7: Divided wrinkle

Finally you can connect wrinkles into one wrinkle. If one real wrinkle is divided into several wrinkles, this method is useful. For that, mark the wrinkles you want to connect, and press the button “Join wrinkles”.

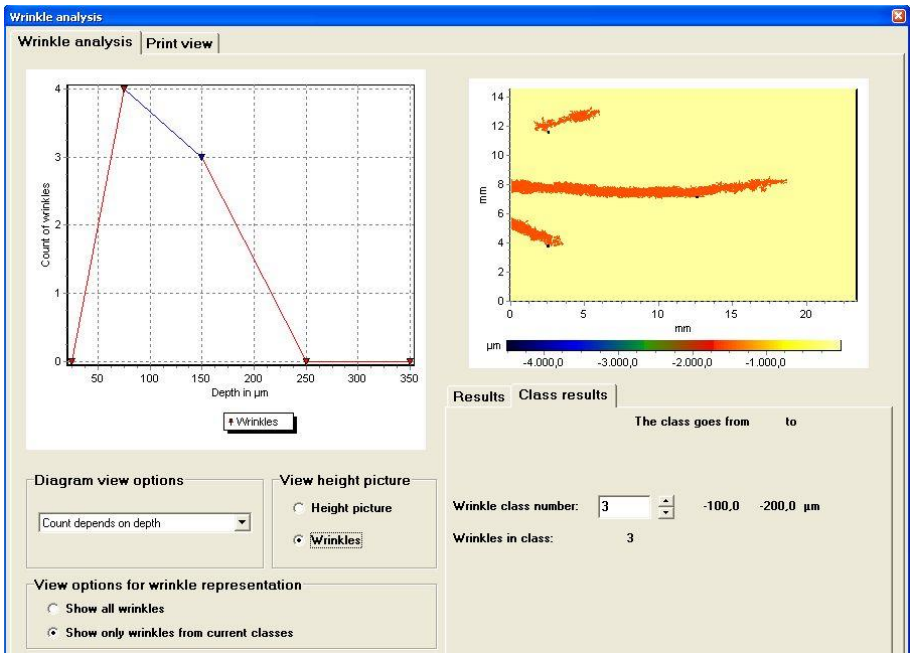


Img. 17.8: Connect wrinkles

After selection, the result dialog is shown a moment later. The height data are filtered automatically with a robust highpass filter. In the resulting dialog, the summarized wrinkles parameter for the whole image and the distribution of the wrinkles in classes of height, volume, area, form factor and length are shown. The form factor is the ratio of the wrinkle’s smoothed circumference to the circumference of a circle of the same area. The length also accounts for coarse branching in the structure. A picture of the segmented wrinkles can be shown, either with all height classes or with only one selected class.

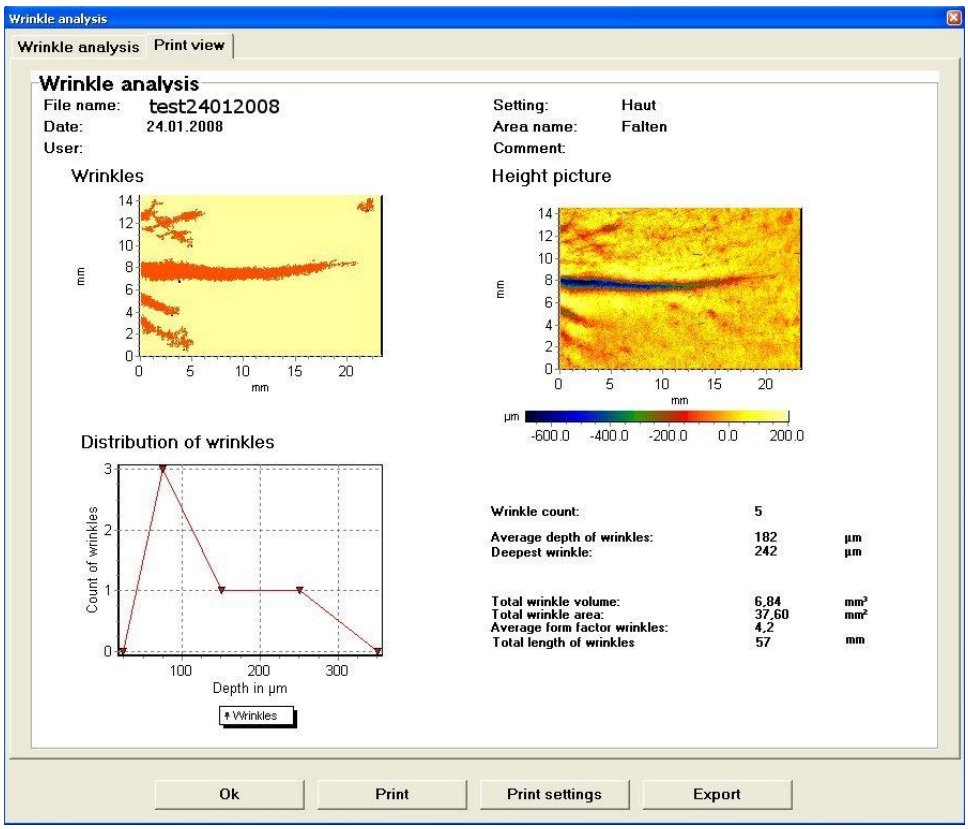


Img. 17.9: Result dialog, all classes shown



Img. 17.10: Only one class shown

The main results with graphical representations are given in the protocol and can be printed or exported as Bmp- or Jpg-picture.

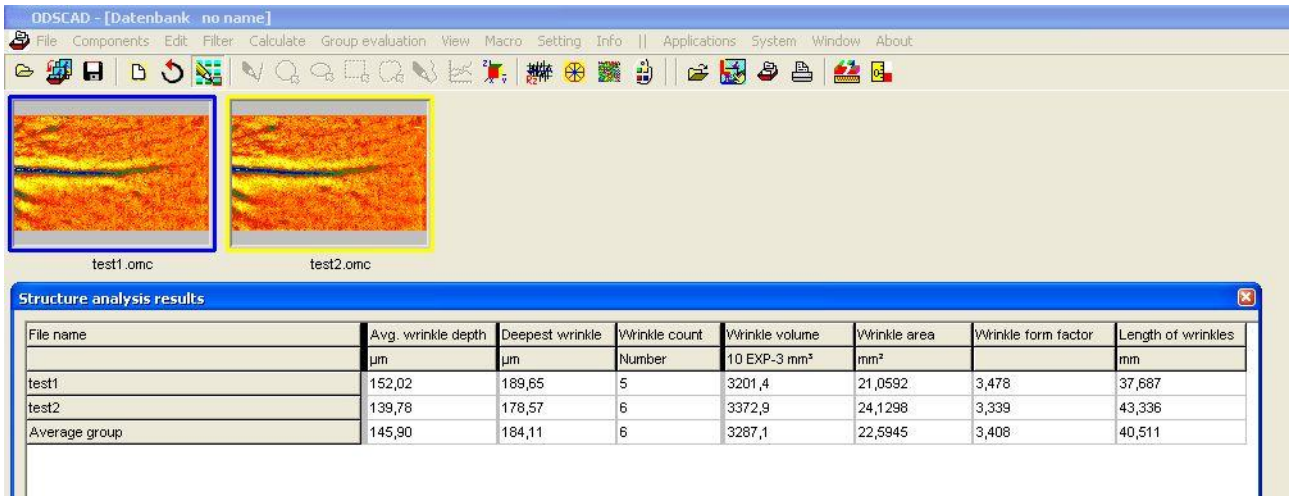


Img. 17.11: Protocol layout

For the analyzed height picture, two text files are generated in the folder of the picture: one file shows the parameters for all wrinkles and there positions and the other one gives the distribution in the classes for all parameters, the summarized parameters and the settings. Additionally, one line with the summarized parameters is added to a text file for protocol purposes. That file with the setting name is saved in the edited result path.

17.4 Analysis of a measuring series in the database module

The wrinkle analysis can also be performed for all files of a measuring series, e.g. to observe the wrinkle alteration for several points in time with statistical significance. For this, all files of one series have to be matched in the database before. Due to the matching, the files contain different invalid areas at the edge that must not be evaluated. Therefore, the software asks to determine the maximum possible rectangular area which is used for analysis. Only marked files are used. The maximum rectangle and the wrinkle selection (in that case) are applied only if all marked files have the same dimensions. Alternatively, an inserted rectangle or the complete area, in case of equivalent ranges, can be analyzed. After starting the wrinkles analysis (press "**Calculate | Wrinkles analysis**") with selection of a settings name and result path in the first dialog, the maximum rectangle is determined and shown, if chosen. Then, the wrinkles of the first marked file are determined and shown in the wrinkle selection dialog. Select the wrinkles, you want to evaluate by mouse (see above). Now, all marked files are analyzed and only those wrinkles are used, which have an overlap to there reference wrinkle of >1% of area. Note that flat wrinkles usually show an irregular structure dominated by the surface roughness and there positions move from picture to picture. Therefore, in order to recognize these wrinkles again, the overlap criterion must not be stronger. The summarized results for all evaluated files can be seen in "**View | Wrinkles analysis results**". As for the evaluation of a single file, the same result files are generated here but with the name tag "DB" for database.


ODSCAD - [Datenbank no name]
File Components Edit Filter Calculate Group evaluation View Macro Setting Info || Applications System Window About
test1.omc
test2.omc
Structure analysis results

File name	Avg. wrinkle depth	Deepest wrinkle	Wrinkle count	Wrinkle volume	Wrinkle area	Wrinkle form factor	Length of wrinkles
	µm	µm	Number	10 EXP-3 mm³	mm²		mm
test1	152,02	189,65	5	3201,4	21,0592	3,478	37,687
test2	139,78	178,57	6	3372,9	24,1298	3,339	43,336
Average group	145,90	184,11	6	3287,1	22,5945	3,408	40,511

Img. 17.12 Result dialog in database

18 Print Folder

With the help of the print folder, measuring results can be prepared for printing. The print folder function makes it possible to arrange height images, cross sections and calculated parameters in any way on a page. The designed pages can be stored in PRT format and printed out directly from the page preview.

To open a new print folder, click the icon or select the menu item **Applications | Open print folder**.

18.1. Insert objects into the print folder / delete objects from the print folder

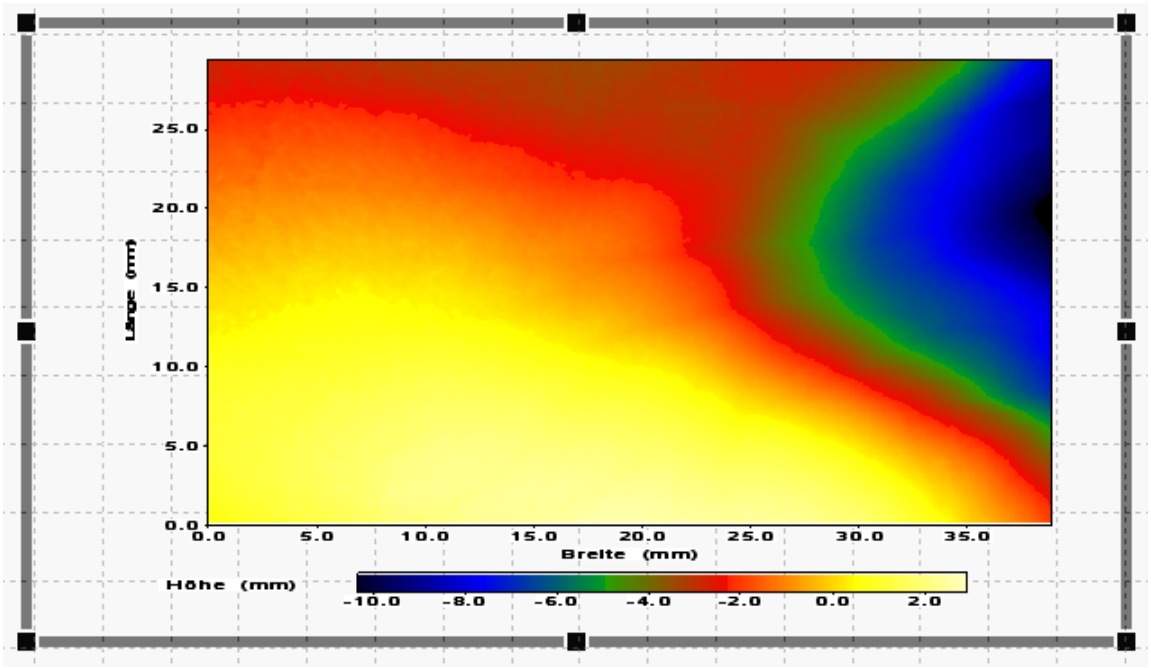
If a current object (e.g. a height picture, cross section etc.) is to be inserted into the print folder, perform the following steps:

Open the object and copy it by means of the button **File | Copy to print folder** or the icon to the clipboard.

Change to the print folder using the menu item **Windows | Print**. If a print folder does not yet exist, open it by means of the button **Applications | Open print folder** or the icon .

Select the menu item **Edit | Insert graphic** or the icon (if the menu point and icon are grey, i.e. inactive, then no picture is in the clipboard).

Click with the mouse in the print page. The object to be inserted is displayed.



Img. 18.1: Print folder with inserted height picture

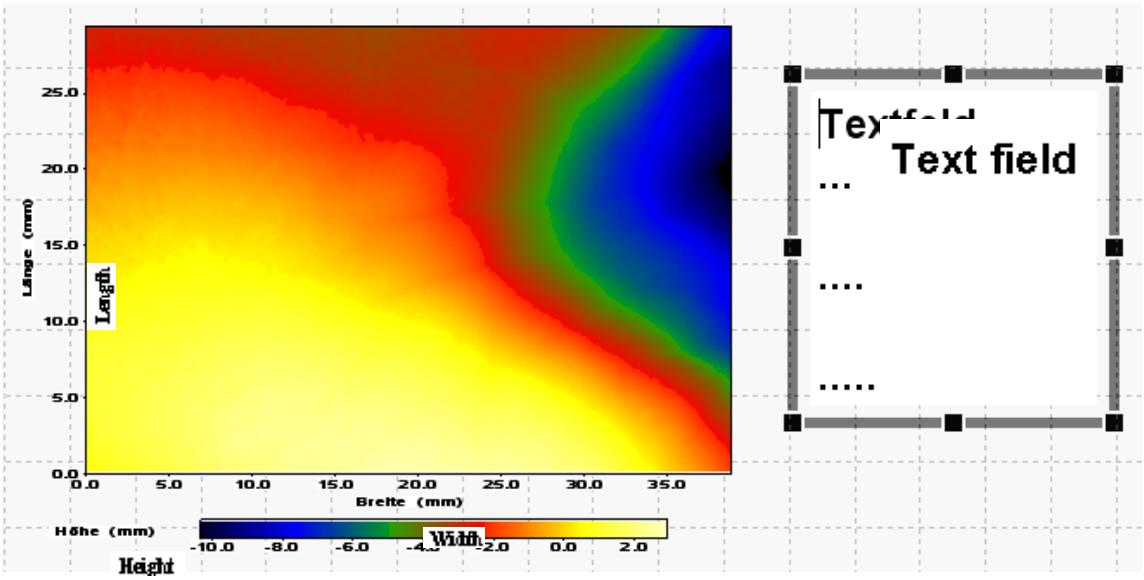
The object can now be positioned on the page as follows:

Click on the object which is to be positioned. An object frame is displayed. Move the mouse over the frame until the cursor changes to a hand. The object can now be moved with held down left mouse button.
The dimensions of the object can be changed by stretching or compressing the object frame (enabled when the simple cursor arrow changes to a two-directional cursor arrow).

If an object is to be deleted from the print folder, then click on the object to be deleted and then press the button **Edit | Delete object** or the icon .

18.2. Create text field

To generate a text field, select the menu item **Edit | Create new text field** or use the icon . Position the mouse cursor in the print folder and press the left mouse button. A text field is displayed. A text field is displayed. After this, a text can be entered. Position and dimensions of the text field can be changed in the same way as described above for objects in the print file.



Img. 18.2: Print file with inserted text field

The text can be edited by means of the following options in the menu item **Edit** or by clicking the appropriate icons:

Select font -

Background colour for text -

Paragraph left-justified -

Paragraph centred -

Paragraph right-justified -

The print folder can be created in portrait or landscape format (select the item **Portrait** or **Landscape** in the menu **View** or click the icons or). Furthermore, the folder can be displayed in the page (print) preview (select the item **Page preview** in menu **View** or click the icon).

To return to the edit mode, select the item **Edit mode** in menu **View** or click the icon .

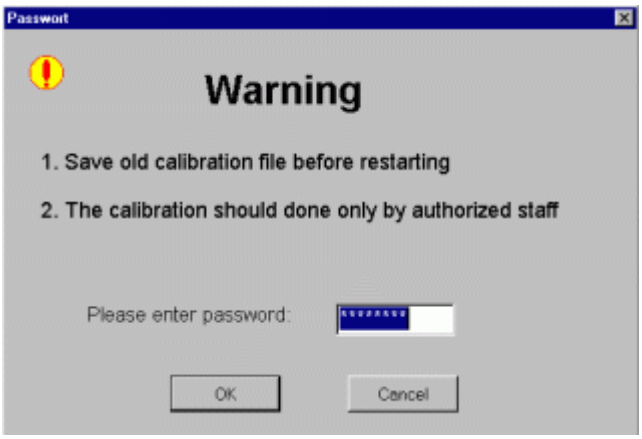
18.3. Printing the page

To print the page, change to the preview page (select the item **Page preview** in menu **View** or click the icon). There, the design of the page can once more be checked in various sizes. To print the page, select the menu item **View | Print** or the button .

The print page can be saved in PRT-Format with help of the menu item **File | Save** or the button . A saved print page can be opened for further processing through the menu item **File | Open** or the button .

19. System Settings

This menu item serves the creation and changing of measuring modes as well as the changing of passwords for the access to calibration and system settings. To open the window “System settings” select the menu item **System | System settings**. The access to this menu is protected by a password. The default password at the delivery of the measuring system is the letter “a”. Enter the password and click **ok**. The window “System configuration” opens. To save any changes made in the system settings, press the button **Save** in the window.



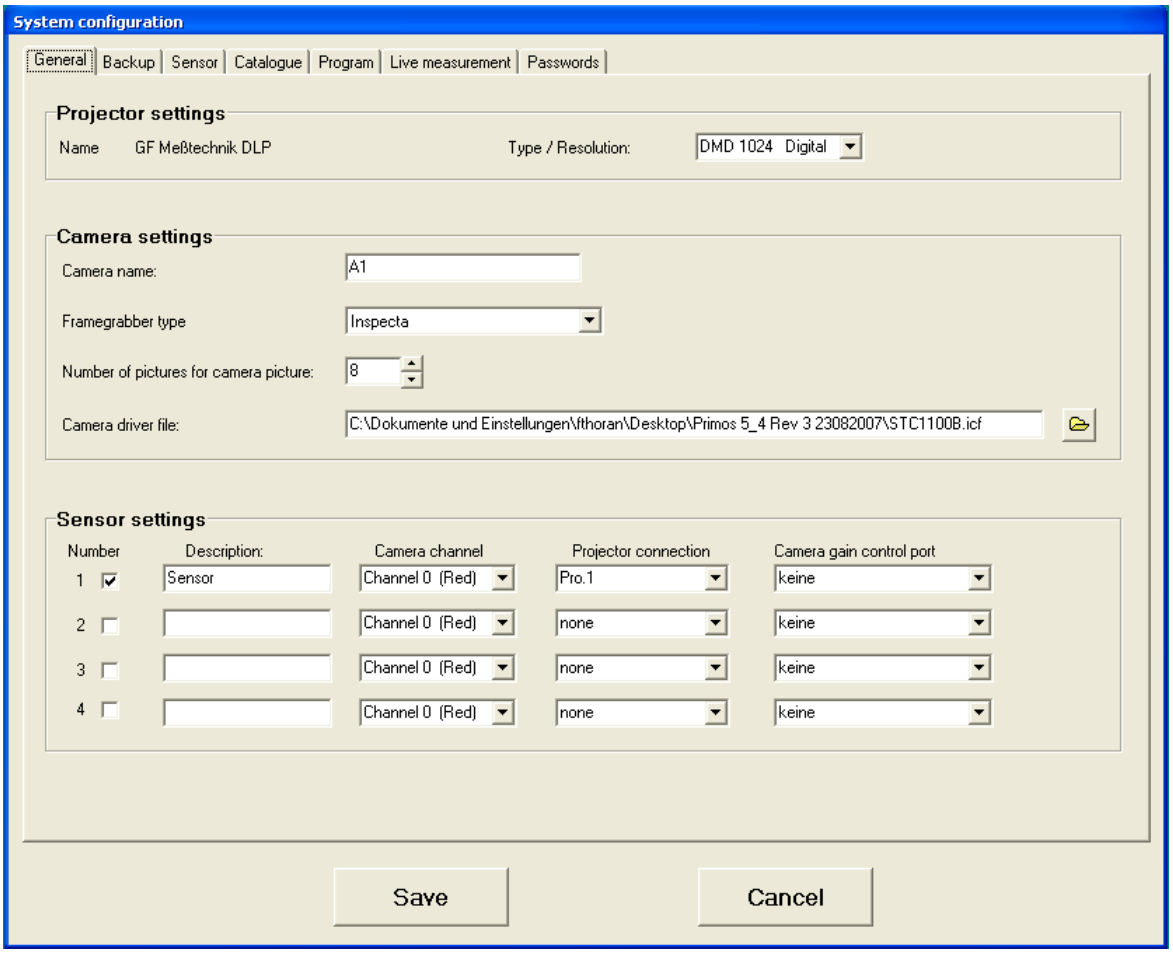
Img. 19.1: Input of password

All settings named in the following part are configured by the manufacturer and in the normal case there is no necessity to change these. If the user would still like to make changes to these settings, then it is advised to consult the measuring device manufacturer or their local representative as incorrect system settings can cause malfunctions of the measuring device.

- **Menu “General”**

In this sub-menu, general projector and camera settings for the concrete measuring system can be found, that are undertaken by the manufacturer and which should **not** be changed by the user as in that case, the operational capability of the measuring device can no longer be warranted. Click the button **General** to change to this sub-menu. In the sub-menu, the following adjustments can be performed:

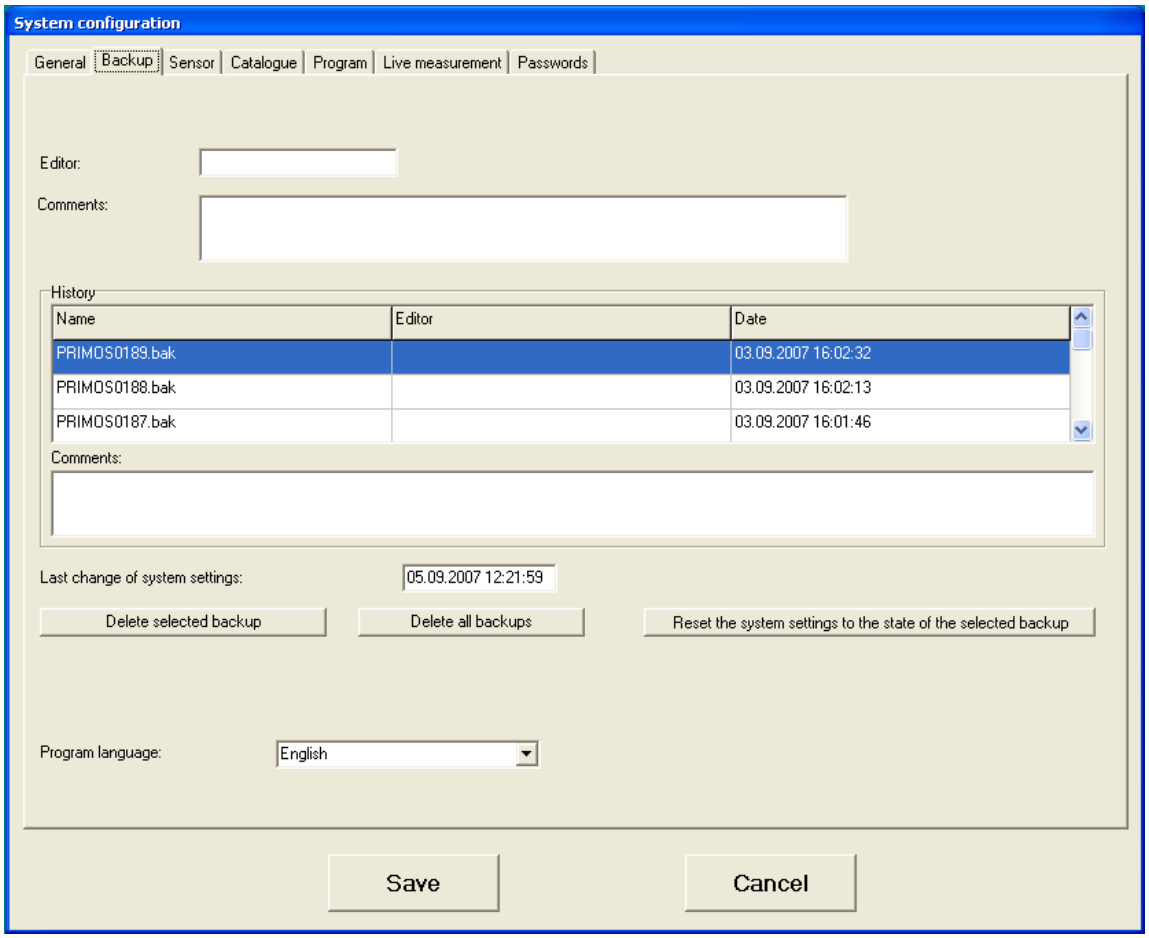
→ projector type used in the optical 3D sensor and its resolution
→ Camera type used in the optical 3D sensor and its resolution.
→ Frame grabber type used in the measuring system.
→ Camera parameter file (“Driver“ = Saving location of the camera driver)
→ For the generation of the camera picture, used number of frames (“camera picture recording”)
→ Channels for the connection of frame grabber and camera



Img. 19.2: System settings “General”

- **Menu “Backup”**

Click the button **Backup** to get into this sub-menu. Here, the language can be chosen for the menus of the measuring, control and evaluation software PRIMOS. Furthermore, the times of any changes to the system settings are displayed.



Img. 19.3: System settings “Backup”

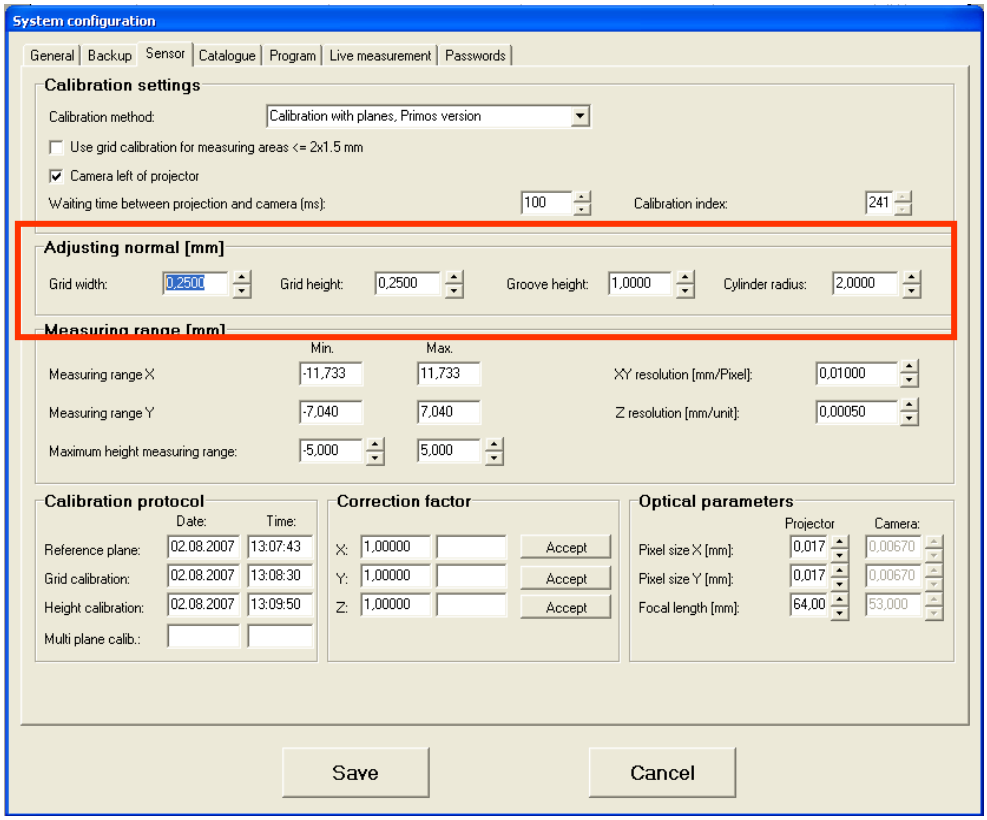
- **Menu “Sensor”**

Press the button **Sensor**, to switch to this sub-menu. The **parameters** (“setting normal in mm”) of the adjusting pieces (grid width and length as well as groove depth) that are delivered with the measuring system are to be entered or corrected in this menu (middle-left of the window). For the setting of the above named parameters, use the scroll buttons to the right of the input fields and set the values of the grid width and length as well as the groove depth to correspond to the values given on the adjusting pieces. In the top right of the window, the time of the last calibration

("Calibration protocol") is displayed. At the bottom left of the window ("Correcting factor of scaling") the possibility stands, in principle, to correct the scaling factor through after an inaccurate calibration, however it is recommended to repeat the calibration in this case as explained in the chapter "Calibration".

The following named settings are **not** allowed to be changed by the user of the measuring device. In the top left of the window, the procedure used for the calibration is selected. In the middle of the window, the coded form of the fringe width ("calib. Index") is displayed that is used for the calibration of the measuring system. The field "Cam. Left" has to be marked when the camera is left of the optical 3D sensor of the projector. If this marking is set incorrectly, a faulty height image is obtained. In the field "Waiting time", the waiting time between the recording of the camera frames during the calibration is set.

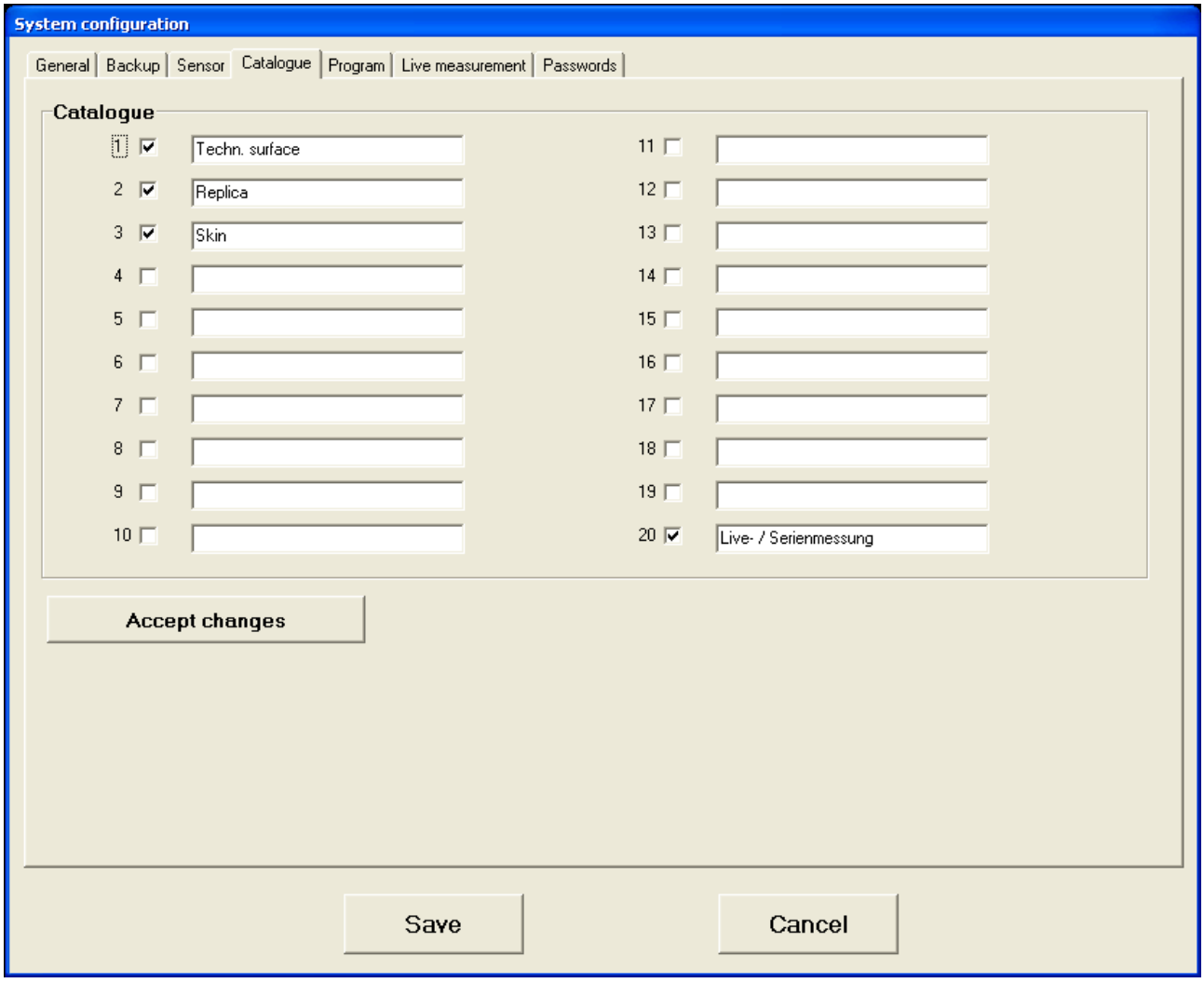
The settings Xmin, Ymin, Zmin, Xmax, Ymax and Zmax in the field "Measuring range in mm" are used only in the case of multilevel calibration. The parameter "XY-Resolution" is not applicable for the CAD-comparison. The displayed "Z-Resolution" is the resolution used by the PRIMOS software. It is dependant on the dimensions of the measuring field. To save the changes, press the button save at the bottom left of the window "System Settings".



Img. 19.4: System Settings "Sensor"

- **Menu “Catalogue”**

Press the button **Catalogue**, to switch to this sub-menu. In this menu, measurement modes can be added or taken from the list of already available measurement modes. To add a measuring mode to the list, mark the box in front of the relevant measuring mode and subsequently press the button **Accept Changes**. To delete a measuring mode out of the list, removing the check from the box in front of the relevant measuring mode and subsequently press the button **Accept Changes**. To save the changes, press the button **Save** in the bottom left corner of the window “System Settings“.



Img. 19.5: System settings “Catalogue”

- **Menu “Program”**

Press the button **Program**, to switch to this sub-menu. In this menu item, new measuring modes can be created or changed for the measuring type “Single measurement“.

For adjustment of measuring modes, act as follows:

→ In the menu **System settings | Catalogue**, select or enter the name of the measuring mode.

→ Encase it is not yet activated, activate the desired measuring mode. (see above). Press the button **Accept Changes** (and subsequently **Save**).

→ Change to the menu **System settings | Program** and select the measuring mode (fields “Catalogue“ and “Name“ in the top left of the window). Continue as follows:

Phase shift:

→ Select in the first field line at the top right of the window, the stripe width and number of pictures for the first measuring sequence. Activate the sequence sequence (set marking in the field “Level 1”). If necessary, adjust and enable further sequence(s) as described above.

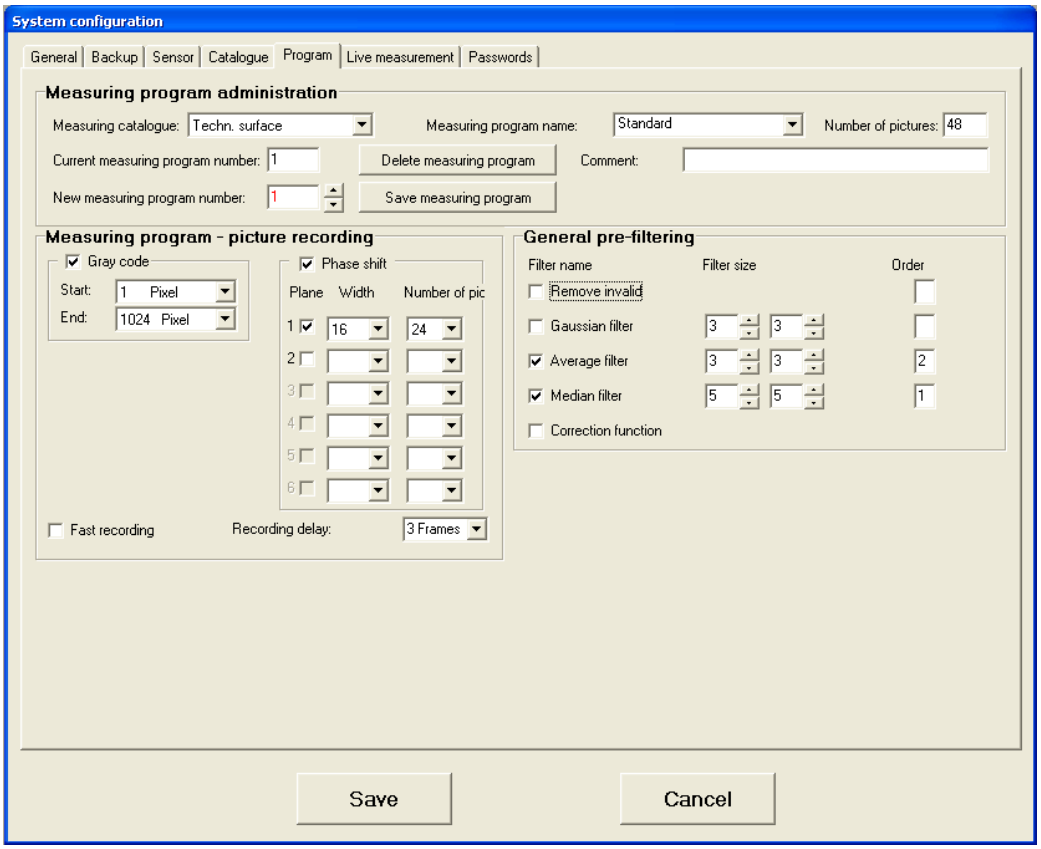
→ Activate the phase shift i.e. mark the field “phase shift“ in the top of the window.

→ If necessary, adjust filter options (field “Pre-filtering” middle right in the window). Enable the types of filters (see also chapter “Evaluation of 3D Data”) in required order of their later application. Adjust the size of filtering in x- and y-direction for each filter in the two fields right of the filter type field. For removal of waviness in the measuring data the field “Correction function” can be enabled.

→ If desired, enter a description in the field “Comment“.

→ To the right of the button **Record with**, select a free ID-Nr. With the scroll button (Red= Occupied, Blue= free).

→ Press the button **Record with** and subsequently **Save**.



Img. 19.6: System settings “Program”

Graycode:

→ In the field “End“ select the final (Maximum) stripe length. In the field “Start” , select the starting stripe width (minimum).

→ Activate the field “Grey code”.

→ If necessary, adjust filter options (see above).

→ If desired, enter a description in the field “Comment“.

→ To the right of the button **Record with**, select a free ID-Nr. using the scroll buttons (Red= Occupied, Blue= free).

→ Press the button **Record with** and subsequently **Save**.

Note: For the use of Gray codes, at least one phase shift sequence must be activated!

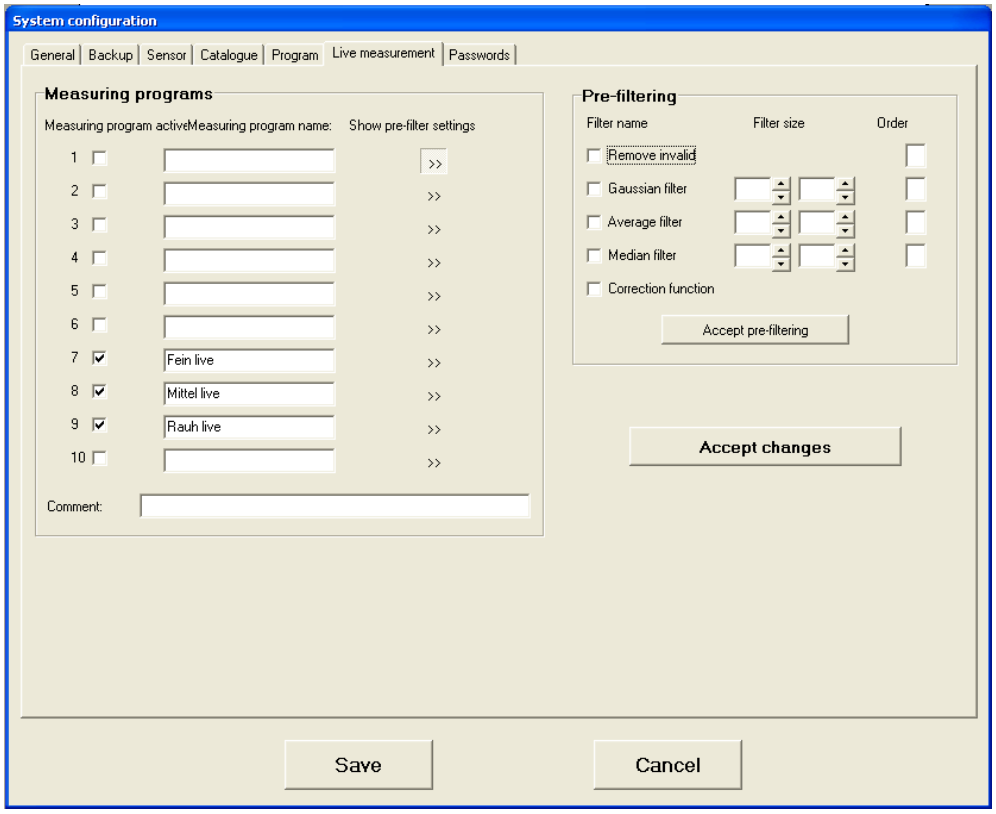
In the field “Delay”, a number of frames can be designated at the beginning of the measurement that are later not used for the calculation of the height image. In the field “Repeat”, It can be designated whether the to the right arranged measuring sequence is used once, twice or more

often. In the field “Picture number“, the number of frames used for the calculation of the height image is given.
For the hardware configuration used in the measuring system PRIMOS compact, the further setting possibilities in the sub-menu are not used.

- **Menu “Live Measurement”**

Press the button **Live Measurement**, to switch to this sub-menu. In this menu, the measuring modes of the measuring types “Live measurement” and “series measurement” can be activated or deactivated or the pre-filtering can be modified.

A change of the settings for the various measuring modes (fine, medium,...) of the live/ series measurement through the customer or the service engineer is not intended. The reason for this is that the Live-/ Series measurement is extremely time critical. So, the program can lose its functional capability through slightly incorrect settings undertaken by an inexperienced user.



Img. 19.7: System settings “Live Measurement”

The customer or service engineer can for this reason, only activate or deactivate the 10 pre-programmed measurement modes (activate or deactivate the relevant mode when necessary;

enter a name for the mode; press the button **Record** and **Save**) and set filter options. (Click on the double arrow to the right of the relevant measuring mode; activate the filter option in the desired order; select the degree of filtering in X- and Y- direction (Filter settings – see section “Menu program“); click on **ok** and subsequently press the buttons **Record** and **Save**). The 10 pre-programmed measuring modes (see table below) make it possible to measure all surfaces that are usually measured live.

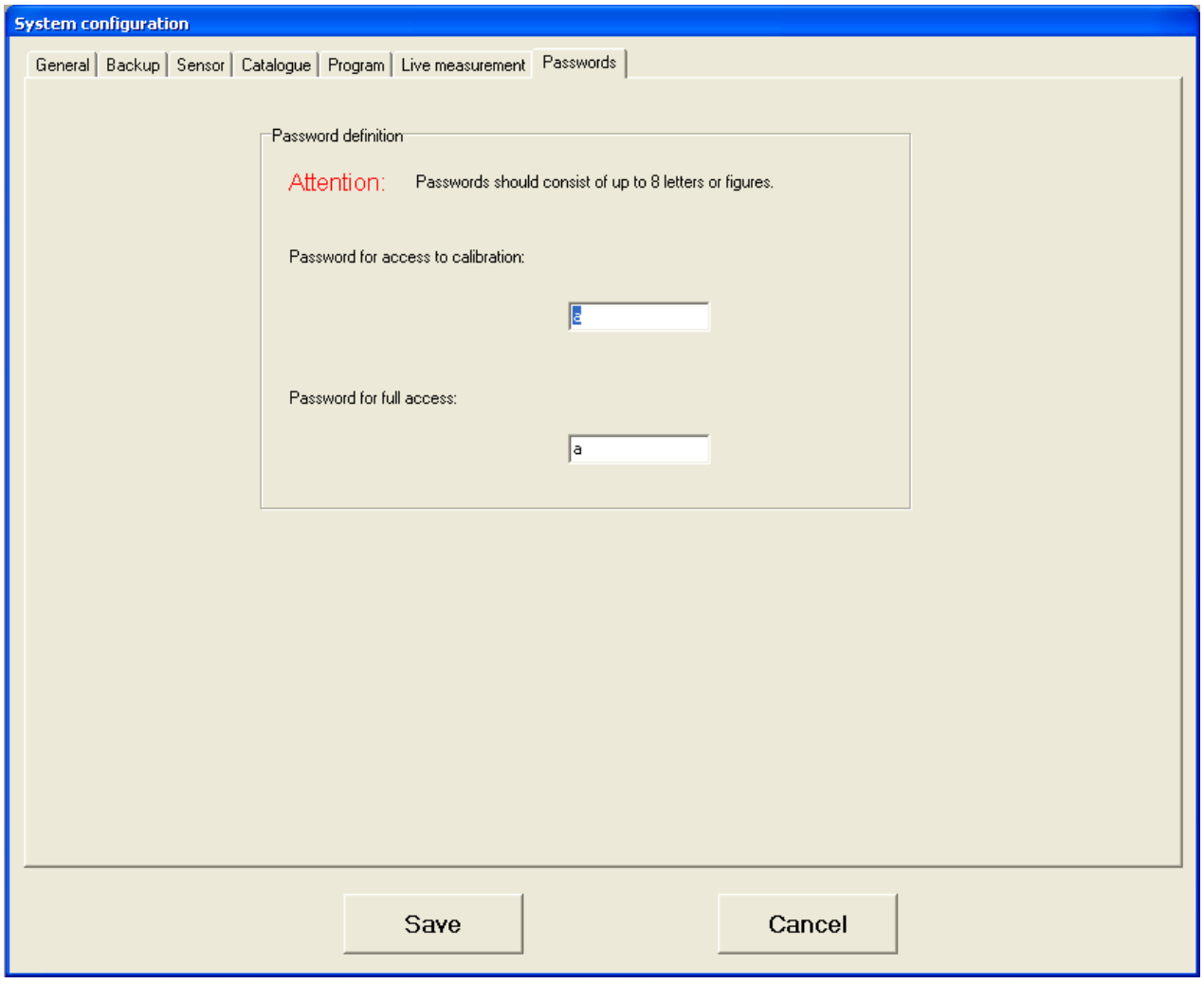
Table 1: Parameters of the measuring modes “Live Measurement“ (Phaseshift)

Nr.	**Stripe width, Pixel**	**Picture number**	**Application**
1	8 32	6 6	deactivated
2	16 64	6 6	Deactivated
3	8 32 128	6 4 4	Deactivated
4	16 64 256	6 4 4	Deactivated
5	8 32 128 512	6 4 4 4	Deactivated
6	8	6	Deactivated
7	16	6	Fine – live
8	32	6	Medium - live
9	64	6	Rough- live
10	128	6	Deactivated

COMMENT: The measuring programs 1 – 5 content several sequences with different stripe widths.

- **Menu “Passwords”**

Press the button **Passwords**, to switch to this sub-menu. In this menu, the passwords for access to the system settings and calibration mode can be changed. The default password on delivery of the measuring system Is the letter “**a**“ for both access types. To change the password, enter the new password in the field “Password for users with access to calibration” and / or “Password for users with all access rights” and press the button **Save**.



Img. 19.8: System settings “Passwords“

20. Brief description of the program functions in the measuring, control and evaluation software Primos – Toolbar

In the tables of this chapter, the program functions of the various menus and sub-menus of the software PRIMOS are shown and a short description of their application is given.

20.1. Main menu / Start window

After running the measuring, control an evaluation software the main / start window of PRIMOS is opened. At the top left edge of the window, the menu bar can be found. Through its menus and sub-menus, the user has access to all functions of the measuring, control and evaluation software. The icon panel below the menu bar serves the calling up of various program functions. All menus and sub-menus of the software PRIMOS are designed in the same way.

Img. 20.1: Menu- and Icon bar in the main-/ starting window

After starting the PRIMOS software, following functions are available in main-/ starting window:

Menu	Button	Icon	Function	Operation
Applications	Open document		Open a stored measuring file and run the topography evaluation program for its further evaluation	Click button or icon; select folder, file format and file name; click “Open” – the file will be opened in the topography evaluation window (work area)
	Open print folder		Open the print folder for design and print-out of evaluated measuring data	Click button or icon - the print folder for design and print-out of evaluated measuring data opens
	Open database		Open the database window of the PRIMOS software	Click button or icon – the database window opens

	Take up height picture into work area		Transfer of 3D measuring data from the measuring program to the topography evaluation program for their further evaluation	Disabled in the main window
	3D matching for elastic surface structures		Opens the program for the 3D matching of elastic surface structures.	Click button or icon - the 3D matching window is opened
	Begin measurement		Open the measuring window	Click button or icon – The measuring window is opened
	Begin calibration		Opens the calibration window.	Click button or icon – the calibration window is opened
	Close		Exit the PRIMOS program	Click button or icon – the PRIMOS program is Closed

Menu	**Button**	**Icon**	**Function**	**Operation**
System	System Settings		Opens the window for the input of system settings	Click button – After entering the password, the window for entering the system settings opens
Window	Overlapped		Overlapped arrangement of open windows	Click button – open windows will be arranged overlapping
	Below		Windows are arranged below one another	Click button – opened windows are ordered underneath one another
	Arrange minimized		Arranges the minimized program	Click button – Minimized program windows are arranged

	windows		windows at the bottom left of the main window	at the bottom left of the main window.
	Minimize, Maximize, Restore		Changes the window size	Click button or icon – the window dimensions are appropriately changed, i.e. minimized, maximized or restored
Help	About PRIMOS		PRIMOS-Version information	Click button – the PRIMOS version information is opened

20.2. Menu “Calibration ”

After opening the program window for the measuring device calibration the following functions are available in the calibration window:

Menu	**Button**	**Icon**	**Function**	**Operation**
File	Save height picture		Saves measuring data (*.fd3, *.omc- oder *.sdf -format)	Click button or icon; Enter file name; Select directory and file format; Press “Save“
	Save camera image		Saves the live camera image	Click button or icon; the camera image is frozen. In the window which opens, enter file name; Press “Save“
	Close		Close calibration window	Click button or icon – the current window (calibration window) is closed
View	Stripes		Projects stripes	Select desired stripe width through button – Stripes of selected width are projected – Or keep clicking the icon until desired stripe width is projected
	Pattern		Projects pattern	Select pattern through button –

				The desired pattern is projected – or continue clicking icon until desired pattern is projected

Menü	Schaltfläche	Symbol	Funktion	Bedienung
View	View settings		Selecting / setting of the orientation of the display of camera image and height image on the monitor relative to the original orientation.	Select the desired orientation of camera and height image display on the monitor, relative to the original orientation via the button (normal = As captured, mirrored horizontal or, turned 180°)
	Camera gain		Selecting the camera enhancement	Select the desired enhancement level of the recording camera with the button
	Projector		Select intensification of the projector light	Select the desired level of projector light intensity through the button – the desired intensity of the projector light is adjusted (Do not change pre-set light intensity!)
	Automatic display of actual pattern		Show the last adjusted pattern automatically when enabling the live picture	Click button – when activated, then (at the next start of the calibration program) the last set pattern is projected when starting the live image.
	Show inverse pattern		Projects inverted pattern	Click button – when activated, the selected pattern is projected inverted

	Live pic. on when starting meas. mode		Enables the live picture automatically when starting the calibration program	Click button – when activated, then (with the next starting of the calibration program) the live image is displayed automatically with the starting of the calibration program.
	Status Information		Display / shield the information line	Click button – the control panel is shown / shielded

Menu	**Button**	**Symbol**	**Function**	**Operation**
View	Control Panel		Display / shield the control panel	Click button – the control panel is shown / Shielded
			Set colour scale for height picture	Click icon – the window for the selection of the colour scale of the height picture opens
Calibration	Start / stop live picture		Start / Stop the display of the live image	Click button or icon – the live image is displayed and with a repeated click, it is hidden
	Determine reference plane		Perform the calibration of the reference level (zero level)	Position the appropriate calibration piece; click button or icon – the calibration of the reference level is carried out automatically
	Start lateral calibration		Perform lateral calibration (X-Y)	Position the appropriate calibration piece; click button or icon – the lateral calibration of the measuring system will be carried out automatically
	Start height calibration with		Perform vertical	Position the appropriate calibration piece; click button

	corrugation		calibration (Z)	or icon – the vertical calibration of the measuring system will be carried out automatically
	Undo calibration		Undo the results of the current calibration	Lick button – The performed calibration is undone
	Start test measurement		Test measurement is performed	Click button or symbol – the 3D Profile of the test object surface (e.g. of the calibration piece) is measured

20.3. Menu “Measuring program ”

After running the measurement program of the PRIMOS software the following functions are available in the measurement window:

Menu	Button	Icon	Function	Operation
File	Open reference picture		Open reference picture for the overlay function	Click button or icon; select folder, file format and file name; click “Open”
	Naming assistant		Open naming assistant window	Click button or icon – the naming assistant window Is opened
	Save height image		Save measuring data (*.fd3-, *.omc- oder *.sdf-format)	Click button, icon or function key; input file name; select folder and file format; click “Save”
	Save camera image		Freeze camera image	Click button or icon – The camera image is frozen and can subsequently be saved as a height image

	Close		Close measuring window	Click button or symbol – The current window (measuring window is closed
Measure	Start / Stop live image		Start / stop the display of live the picture	Click button, icon or function key – the live is shown; repeat click button, icon or function key – the live picture is hidden
	Start measurement		Perform single measurement	Click button, icon or function key – a single measurement of the measuring object is carried out

Menu	**Button**	**Icon**	**Function**	**Operation**
Measure	Start / Stop live measurement		Perform live measurement	Click button, icon or function key – a single measurement of the measuring object is started; to end the measurement, re-click the button, icon or function key; The lastly taken height image is taken over
	Start series measurement		Perform series measurement	Click button, icon or function key – a series of single measurements is carried out in the live mode. Number of single measurements and the space of time between each measurement must be set in the setting field of the measuring program before measurement.
	Use normal		Selection of the	Click the button for the

	measuring mode for the series measurement		measuring mode of the single measurement for the performing of series measurements	activation of the measuring mode, to deactivate the measuring mode, re-click the button
View	Stripes		Project stripes	Select the desired stripe width through the button – Stripes of the selected width are projected – or click on the button or function key repeatedly to project desired stripe width
	Pattern		Project pattern	Select desired pattern through the button – The selected pattern is projected or click icon or function key to project desired pattern

Menu	**Button**	**Icon**	**Function**	**Operation**
View	View settings		Selection / Setting of the orientation of the display of camera image and height image on the monitor relative to the original orientation.	Select the desired orientation of camera and height image display on the monitor, relative to the original orientation via the button (normal = As captured, mirrored horizontal or, turned 180°)
	Start / Stop overlay		Turn overlay function on / off	Click button or icon – The overlay function is turned on with one click and off with another
	Camera gain		Selection of camera enhancement	Select the desired enhancement level of the recording camera with the

				button
	Projector		Select intensity of projector light	Select the desired level of projector light intensity through the button – the desired intensity of the projector light is adjusted (Do not change pre-set light intensity!)
	Automatic display of actual pattern		Show the last adjusted pattern automatically when enabling the live picture	Click button – when activated, then (at the next start of the calibration program) the last set pattern is projected when starting the live image.
	Display inverse pattern image		Project inverted pattern	Click button – when activated, the selected pattern is projected inverted
	Live pic. on when starting meas. mode		Enables the live picture automatically when starting the calibration program	Click button – when activated, then (with the next starting of the calibration program) the live image is displayed automatically with the starting of the calibration program.

Menu	**Button**	**Icon**	**Function**	**Operation**
View	Function key buttons		Display / hide the function keys	Click button – display or hide the function keys
	Status Information		Display / shield the information line	Click button – the control panel is shown / shielded
	Control panel		Display / shield the control panel	Click button – the control panel is shown /

				shielded
Height image	Color coded height image		Selection of the display type of the measuring results in the measuring window.	Click button – The result of the measurement is displayed as a color coded height image
	3D depiction of color coding		Selection of the display type of the measuring results in the measuring window	Click button – The result of the measurement is displayed as a color coded 3D depiction
	3D depiction with photo simulation		Selection of the display type of the measuring result in the measuring window	Click button – The result of the measurement is displayed as a 3D depiction in photo simulation
	3D depiction with color coded fine structure		Selection of the display type of the measuring result in the measuring window	Click button – the result of the measurement is displayed as a 3D depiction with color coded fine structure
	3D- depiction with texture		Selection of the display type of the measuring result in the measuring window	Click button – the result of the measurement is displayed as a 3D depiction with texture
	3D- depiction with net course in X direction		Selection of the display type of the measuring result in the measuring window	Click button – the result of the measurement is displayed as a 3D depiction with net course in X direction
	3D- depiction with net course in Y direction		Selection of the display type of the measuring result in	Click button – the result of the measurement is displayed as a 3D depiction

			the measuring window	with net course in Y direction

Menu	Button	Icon	Function	Operation
Height image	3D- depiction with net course in both directions		Selection of the display type of the measuring result in the measuring window	Click button – the result of the measurement is displayed as a 3D depiction with net course in both directions
	Turn		Activation of the function “turn 3D depiction“	Click button – the function “Turn 3D depiction“ is active; functionality also see section “3D depiction of height pictures“
	Zoom		Activation of the function “zoom 3D depiction“	Click button – the Function “zoom 3D depiction“ is active; functionality also see section “3D depiction of height pictures“
	Undo		Restore the 3D depiction back to its original state	Click symbol – the 3D depiction is restored back to its original state
Color setting	Color scale of height image		Select color scaling of height image	Click button; select the color scale in the window that opens and confirm with the “OK“ button
	Background color		Select background color	Click button; select color in the window which opens and confirm with the “OK“ button
	Color scale for 3D depiction		Select color scale for 3D depiction	Click button; Select color scale in the window which opens using the mouse and confirm with the “OK“ button

	Color scale for fine structure		Select color scaling for fine structure	Click button; Select color scale in the window which opens using the mouse and confirm with the “OK“ button

Menu	**Button**	**Icon**	**Function**	**Operation**
Color setting	Color scale for Photo simulation		Select color scale for Photo simulation	Click button; Select color scale in the window which opens using the mouse and confirm with the “OK“ button
	Color scale for texture		Select color scale for texture	Click button; Select color scale in the window which opens using the mouse and confirm with the “OK“ button
	Color scale for net depiction		Select color scale for net depiction	Click button; Select color scale in the window which opens using the mouse and confirm with the “OK“ button
Evaluate	Macro file		Starting a macro file for the height image evaluation	Click button; Select macro; Click “OK” – the selected macro is started automatically for the measuring data evaluation directly after the measurement

20.4. Menu “Open Document ° ”

After opening a saved measuring file or changing from the measuring window to the data evaluation, the following functions are available in the topography evaluation window (work area):

Menu	Button	Icon	Function	Operation
File	New		Deletes all markings drawn in the height image	Click button or icon – all markings drawn into the height image are deleted
	Open		Opens a saved measuring file	Click button; select directory, file format and file name, click “open“ – the file is opened in the topography evaluation window (Work area)
	Save as …		Save measuring file	Click button or icon; Enter file name; select file format and directory for saving; click “Save“ – file is saved
	Export …		Exporting a height picture as a graphic file	Click button or icon; Enter file name; select file format and directory for saving; click “Save” Formats *.txt and *.dat – Saving of 3D data Formats *.bmp and *.pcx – only saving of images Formats *.emf and *.wmf – Saving of colour coded images and displayed scaling
	Copy into print file		Copying of the current display into the clipboard	Click button or icon – the current display is copied into the clipboard

Menu	Button	Icon	Function	Operation
File	Close		Closing of the window / work area	Click button or icon – the active window is closed
Edit	Undo		Undoing the last data evaluation operation	Click button – the last undertaken operation is undone
	Zoom		Activation of the zoom function for the height image	Click button or icon; position cursor on the corner of the area which is to be zoomed in on; press the left mouse button and hold down; move the cursor to the opposite corner of the area which is to be zoomed in on; release mouse button – the corresponding area of the height image is displayed enlarged To return to the un-zoomed state, click the right mouse button anywhere in the zoomed area.
	Cut		Cutting out a marked area of a height picture	Click button – the marked area(s) of the height image are cut out
	Trim		Cutting out the height picture outside of a marked area	Click button – the area(s) around markings in the height images are cut out
	Copy parameter		Copies parameters of the marking (in the height picture) into the clip board	Click button – the markings (in the height picture) will be copied into the clip board so they can subsequently be inserted in to another height picture
	Insert parameter		Inserting parameters	Click button – the markings

			of a marking (into a height image) out of the clipboard	previously copied onto the clipboard are now inserted into a height image.

Menu	**Button**	**Icon**	**Function**	**Operation**
Edit	Open parameter		Insert parameters of marking (into the height picture) from a marking file	Click button; select and open the appropriate marking file (format *mrk). – the markings stored in the marking file are inserted into the height picture
	Save parameter		Saving the parameter of a marking (in the height image) in a marking file.	Click button; enter file name; select folder for storage; click “Save”– the markings in the current height picture are stored in the marking file
	Inverse picture		Inverts the height picture (calculation of the height picture print)	Click button – the height picture is inverted
	Vertical mirror		Mirrors the height picture vertically	Click button – the height picture is mirrored vertically
	Horizontal mirror		Mirrors the height picture Horizontally	Click button – the height picture is mirrored horizontally
	Rotate 90° left		Rotates the height picture 90° left	Click button – the height picture is rotated 90° left
	Rotate 90° right		Rotates the height picture 90° right	Click button – the height picture is rotated 90° left
	180° rotate		Rotates the height picture 180°	Click button – the height picture is rotated 180°

Menu	Button	Icon	Function	Operation
Edit	Rotate free		Rotate the height picture a freely selectable angle	Click button; select angle and direction of rotation; click “OK” – the height picture is rotated corresponding to the selected angle and direction of rotation
	New scale		Change the scaling of the height picture	Click button; select the scaling factors (x, y , z) and the height offset (z) for re-scaling of the height picture; click “OK” – the height picture will be re-scaled corresponding to the entered scaling factors (x, y , z) and the height offset (z)
	New height scaling		Change the height resolution of the height picture	Click button; select value and measure of the new height resolution; click “OK” – the height resolution of the height picture will be changed corresponding to the entered value
Mark	Draw lines		Mark a line in the height picture	Click button or icon; position the cursor in the height picture at the starting point of the line to be drawn; click the left mouse button; hold it and move the cursor to the end point of the line to be drawn; release the left mouse button – the line is drawn in the height picture
	Draw circle		Mark a circle in the height picture	Click button or icon; position the cursor in the height picture at a point on the circle curve to be

				drawn; click the left mouse button; hold it and move the cursor in the height picture ; when the circle has the desired dimension and position release the left mouse button – the circle is drawn in the height picture

Menu	**Button**	**Icon**	**Function**	**Operation**
Mark	Draw ellipse		Mark an ellipse in the height picture	Click button or icon; position the cursor in the height picture at a point on the ellipse curve to be drawn; click the left mouse button; hold it and move the cursor in the height picture ; when the ellipse has the desired dimension and position release the left mouse button – the ellipse is drawn in the height picture
	Draw rectangle		Mark a rectangle in the height picture	Click button or icon; position the cursor in the height picture at the start point (edge) of the rectangle to be drawn; click the left mouse button; hold it and move the cursor in the height picture; when the rectangle has the desired dimension and position release the left mouse button – the rectangle is drawn in the height picture
	Draw polygon		Mark a polygon in the height picture	Click button or icon; position the cursor in the height picture at the start point of the polygon to be drawn; click the left mouse

				button; move the cursor to the next corner of polygon; click the left mouse button; etc.; after clicking the left mouse button for the last corner of polygon click the right mouse button – the program connects the first and the last corner of polygon = the polygon is drawn

Menu	**Button**	**Icon**	**Function**	**Operation**
Mark	Draw freehand line		Mark a freehand line in the height picture	Click button or icon; position the cursor in the height picture at the starting point of the freehand line to be drawn; click the left mouse button; move the cursor to the next corner of freehand line; click the left mouse button; etc.; after clicking the left mouse button for the last corner of freehand line, click the right mouse button – the freehand line is drawn
	Define background depth		Change the background depth, i.e. background colour of the height picture	Click button or icon; position the cursor in the height picture at a point which has the colour requested as background colour; click the right mouse button; in case that following will be cut out parts of the height picture the colour of these areas cut out will be set to the selected colour.
	Define line		Set lines with defined position in the height picture	Draw a number of lines approximately at the requested positions; click button; select in

				the window which opens the line number and change the position of start and/ or end point of line as requested; click “OK” in the right upper corner of the input window; select the next line number and continue as described; after all changes are made click “OK” at the bottom of window
Filtern	Align		Align the height picture to its averaged plane	Click button – reorientation of the height picture to its average plane or a plane defined by before marked areas

Menu	**Button**	**Icon**	**Function**	**Operation**
Filter	Polynomial filter		Remove the deviation from a geometric form corresponding to selected class of polynomial	Click button; select in the window which opens the rank of polynomial; click “Evaluate”; click “Difference” – the height picture after removal of geometric form will be shown
	Remove invalid values		Assigning of adjacent height value in case of absence of own height value for the measuring point	Click button – measuring points with missing height values will be assigned height values of adjacent measuring points
	Remove hairs		Elimination of hairs from the measuring data of a skin surface	Click button – hairs will be removed from the height picture
	Gaussian filter		Application of a Gaussian filter on the height picture	Click button; select in the window which opens the area, the direction and the size

				of filter application; click “OK” – the height picture after application of the Gaussian filter will be shown
	Median filter		Application of a median filter on the height picture	Click button; select in the window which opens the area, the direction and the size of filter application; click “OK” – the height picture after application of the median filter will be shown
	Average filter		Application of an average filter to the height picture	Click button; select in the window which opens the area, the direction and the size of filter application; click “OK” – the height picture after application of the average filter will be shown
	Robust polynomial		Apply a robust polynomial filter to the height picture	Click button – the height picture after application of the robust polynomial filter will be shown

Menu	**Button**	**Icon**	**Function**	**Operation**
Operate	Define as reference		Define the open (active) height picture as reference measurement	Click button - the open (active) height picture will be defined as reference measurement
	Open reference		Open a measuring file as reference measurement	Click button: select folder, file format and file name; click “Open” - a measuring file for use as reference measurement will be opened
	Meas. Data +		Calculate the sum of 2	After opening a measuring file

	Reference		height pictures	for use as reference measurement or defining an open (active) height picture as reference measurement open a second measuring file; click the button – the shown height picture is the result of the mathematical operation “Measuring data + reference data”
	Meas. Data - Reference		Calculate the difference of 2 height pictures	After opening a measuring file for use as reference measurement or defining an open (active) height picture as reference measurement open a second measuring file; click the button – the shown height picture is the result of the mathematical operation “Measuring data - reference data”
	Reference - Meas. Data		Calculate the difference of 2 height pictures	After opening a measuring file for use as reference measurement or defining an open (active) height picture as reference measurement open a second measuring file; click the button – the shown height picture is the result of the mathematical operation “Reference data - Measuring data”

Menu	Button	Icon	Function	Operation
Operate	Meas. Data * Reference		Calculate the product of 2 height pictures	After opening a measuring file for use as reference measurement or defining an open (active) height picture as reference measurement open a second measuring file; click the button – the shown height picture is the result of the mathematical operation “Measuring data / Reference data”
	Meas. Data / Reference		Calculate the quotient of 2 height pictures	After opening a measuring file for use as reference measurement or defining of an already opened file as reference measurement, open a second file; press button – the displayed height image is the result of the mathematical operation “Measuring data / Reference data“
Evaluate	Surface size		Determine the “stretched” area of surface, marked before in height picture	Click button; the result indicated in the tool bar at the left side of the window is the “stretched” area of the height image or its part marked before
	Surface minimum, maximum		Determine the height value of the highest and the lowest measuring point of the 3D picture	Click button – in the tool bar will be indicated the height of highest and lowest measuring point of the 3D picture or its part marked before
	Determine lump parameters		Detected automatically lumps in	Click button – for structures like nevus, lumps, … will be indicate

			the height picture of skin and determine their geometric parameters	the position, the volume, the area and the maximum height

Menu	Button	Icon	Function	Operation
Evaluate	Volume (W)		Determine volume of height profile(or a part of it) below a reference plane	Click button – in the tool bar will be indicated the volume of height profile (or a marked part of it) below a reference plane
	Volume (M)		Determine volume of height profile (or a part of it) above a reference plane	Click button – in the tool bar will be indicated the volume of height profile (or a marked part of it) above a reference plane
	Volume (N)		Determine volume of height profile (or a part of it) below and above a reference plane	Click button – in the tool bar will be indicated the volume of height profile (or a marked part of it) below and above a reference plane
Parameters	Surface roughness		Determine area roughness parameters	Click button or icon – the window for calculation of area roughness parameters opens
	Star roughness		Determine star roughness Parameters	Click button or icon – the window for calculation of star roughness parameters opens
	Define reference plane		Determining a selected area in a height image as the reference plane	Mark an area in the height image; press button – the marked area in the height image is made the reference plane

	Calculate middle difference		Determining the middle distance from areas marked in the height image	Mark an area in the height image and define it as reference plane; mark a second area in the height picture; press button – The middle distance of the two areas is calculated and displayed in the tool bar

Menu	**Button**	**Icon**	**Funktion**	**Operation**
View	Show entire picture		Show the complete height picture; possibility of magnification	If enabled (clicked) the complete height picture will be shown
	Show reference area		Show reference areas defined in the height picture	When activated (clicked), only the areas defined as reference planes are displayed
	Show marked area		Show only areas marked in the height picture	When activated (clicked), only the marked areas of the height image are displayed.
	Automatic scaling		Automatic height scaling – Regular colour distribution from the lowest to the highest measuring point	When activate (clicked), then an even colour distribution is used for the scaling of the height image.
	Free scaling		Free height scaling – Possibility of coloured highlighting a small height range	Press button; in the window which opens, change min. and max. height values; click “OK“ – the scaling area of the height image is changed
	Non-linear scaling		Possibility of special highlighting of interesting height	Press button; In the histogram that opens, click a red dot with left mouse button so the dot

			ranges. Available colours of colour panel can be distributed non-linearly within the whole height range.	turns green; move cursor over the blue histogram line; click left mouse button and move with held down mouse button – non linear red histogram line appears i.e. scaling is non linear.

Menu	**Button**	**Icon**	**Function**	**Operation**
View	Colour coding		Possibility of visualisation some surface defects by displaying the position of two intersections by means of three colours	Click button – a window for adjusting the position of 2 height levels through scroll bar is opened – the surface portion of the 3 height areas is given numerically and the 3 height areas are displayed in the height image with the help of 3 colours.
	Histogram of the height image		Display of the frequency distribution of the height values	Click button – a histogram window of frequency distribution of height values opens; the number of classes for the calculation of the frequency distribution and the displayed height area can be entered; The data for the corresponding class are displayed in the right side of the window when the cursor is positioned in the histogram
	Show sectional lines		Displays a cross-sectional picture (2D profile) for line(s) previously marked in the height picture	Click button or icon – the window for presentation of 2D profiles (cross-sectional pictures) for line(s) marked before in the height picture

				opens
	Smoothed intersecting lines		Show smoothed intersecting lines	When activated, the intersecting lines are displayed smoothed in the window for showing 2D profiles
	3D representation of height picture		Displays a 3D picture of the colour coded height picture	Click button or icon – the window for 3D representation of the colour coded height picture opens
	File information		Displays information stored in the measuring file additional to height values.	Click button or icon – a window with information about the measuring file opens; additional information can be added

Menu	**Button**	**Icon**	**Function**	**Operation**
View	Tool bar		Display / hide the toolbar	Click button – the tool bar will be shown / hidden
	Info line		Display / hide the info line	Click button – the info line will be shown / hidden
Settings	Select colour table		Set colour scale for height picture	Click button or icon – the window for selection of colour scale of height picture opens
	Select font		Set text font for graphic output and printing of measuring results	Click on button or icon – the window for selection of the text font for graphic output and printing of measuring results opens
Macro	Start recording		Begin macro recording	Click button - the macro recording is started
	End recording		End macro recording	Click button – the macro recording is ended

	Macro info		Display of info for the saved macros	Click button - a window with information regarding the saved macros opens
	Macro protocol		Display of work Steps during execution of a macro	Click button – a window opens in which all the work Steps are protocolled during the execution of a macro

20.4.1. Menu “3D representation of height picture ”

After running the 3D representation of the colour coded height picture the following functions are available:

Menu	Button	Icon	Function	Operation
File	Open		Opens saved 3D measuring file (*.fd3, *.omc, *.sdf)	Click button or icon; select folder, file format and file name; click “Open”
	Export		Saving of a 3D image as picture file (*.bmp)	Click button; Enter file name; Choose directory for saving; Click “Save”
	Copy to print file		Copying the current image to the clipboard	Click button or icon – the current depiction is copied into the clipboard
			Reset height image to original state	Click icon – the 3D image is set back to ist original state
	Close		Closing the window of the 3D image	Click button or icon – the active window is closed
View	Zoom / Shift		Zoom or shift the 3D representation	Click button or icon – if enabled the 3D representation can be zoomed (hold left mouse button and move the mouse) or shifted (hold right mouse button and

				move the mouse) on the screen by means of the mouse

Menu	Button	Icon	Function	Operation
View	Rotate		Rotate 3D image	Click button or icon – if enabled the 3D representation can be rotated (hold left mouse button and move the mouse – rotation axis x and z; hold right mouse button and move the mouse – rotation axis y) on the screen by means of the mouse
	Height picture with reduced resolution		Show the 3D representation with reduced resolution	Click button or icon – if enabled the 3D representation will be shown during rotation with reduced resolution = faster rotation
	Height picture with full resolution		Show the 3D representation with full resolution	Click button or icon – if enabled the 3D representation will be shown during rotation with full resolution = slower rotation
	Grid in X-direction		Show the 3D representation as height lines in X-direction	Click button or icon – if enabled the 3D representation will be shown as height lines in X-direction
	Grid in Y-direction		Show the 3D representation as height lines in Y-direction	Click button or icon – if enabled the 3D representation will be shown as height lines in Y-direction
	Grid in both directions		Show the 3D representation as height lines in X and Y-direction	Click button or icon – if enabled the 3D representation will be shown as height lines in X and Y-direction

	Photo simulation		Show the 3D representation as photo simulation	Click button or icon – if enabled the 3D representation will be shown as photo simulation.
	Frame off		Show the 3D representation without frame	Click button or icon – if enabled the 3D representation will be shown without frame

Menu	**Button**	**Icon**	**Function**	**Operation**
View	Line frame		Show the 3D representation with frame	Click button or icon – if enabled the 3D representation will be shown with frame
	Rahmen mit Farbfüllung		Show the 3D representation with closed frame	Click button or icon – if enabled the 3D representation will be shown with closed frame
	Smoothed Depiction		3D depiction in smoothed version	When activated (clicked) the image is shown in ist smoothed version
	Automatic Z-scaling		Automatic height scaling – Regular colour distribution from the lowest to the highest measuring point	Click button – a regular colour distribution from the lowest to the highest measuring point is used
	Free Z-scaling		Free height scaling – Possibility of coloured highlighting a small height range	If enabled (clicked) the scaling range can be reduced for highlighting a small height range
	Status line on/off		Display / hide the status line	Click button – the status line will be shown / hidden
Settings	Select colour table		Set the colour scale the for 3D representation of the height picture	Click button or icon – the window for selection of colour scale of height picture opens

	Select background colour		Set colour for the background of the 3D representation	Click button or icon – the window for selection of background colour of 3D representation opens

20.4.2. Menu “Show sectional lines ° ”

After opening the window for the display of cross-sectional picture (2D profile) the following functions are available:

Menu	Button	Icon	Function	Operation
File	Redraw		Redraw the cross-sectional picture. All markings and inscriptions will be deleted.	Click button or icon – all markings and inscriptions are deleted
	Save as		Store the cross-sectional picture as 2D cut line file (*.cd2)	Click button or icon; input file name ; select folder for storage; click “Save”
	Import data		Import an cross-sectional picture stored as ASCII file (*.txt)	Click button; select folder and file name; click “Open”
	Export data		Export the cross-sectional picture as ASCII file (*.txt)	Click button or icon; input file name ; select folder for storage; click “Save”
	Export graphic		Export the graphics to Windows- Metafile-Format	Click button or icon; input file name; select file format and folder for storage; click “Save” formats *.emf and *.wmf – storage of picture and indicated scaling

	Copy to print folder		Copy the current image to clipboard	Click button or icon - the current presentation is copied to the clipboard
	Close		Closes the 2D window	Click button or icon – the current window is closed

Menu	**Button**	**Icon**	**Function**	**Operation**
Edit	Align		Align the cross-sectional picture	Click button or icon – the curve will be aligned
	Align by lines		Align cross-sectional picture to a straight-line through two points marked before. The above mentioned straight-line in this case will be aligned parallel to X-axis.	Mark two points on the curve; click button - the curve will be aligned so that straight-line through the two marked points will come parallel to X-axis
	Polynomial filter		Apply the polynomial filter to cross-sectional picture Removes geometric form deviations from cross-sectional picture corresponding to selected class of polynomial	Click button; select in the window which opens the size of filter application; click “Calculate” – the polynomial coefficients will be indicated; click “Polynomial” or “Difference” to see the corresponding curve
	Lorenz filter		Apply the Lorenz filter to the cross-sectional picture	Click button – the curve after application of the filter will be shown
	Lorenz low pass filter		Apply the Lorenz low pass filter to the cross-sectional picture	Click button – the curve after application of the filter will be shown

View	Show real XY-ratio		Show cross-sectional picture with maximum scaling of Y axis or with scaling in real X-Y ratio	Click button – if the button is enabled the curve will be shown with scaling in real X-Y ratio, if the button is disabled the curve will be shown with maximum scaling of Y axis
	Zoom		Displays the cross section in various enlargements	Select the enlargement of cross section in the toolbar – the curve is displayed corresponding to the selected enlargement; when the button is automatically marked, the curve is displayed in maximum Y scaling

Menu	**Button**	**Icon**	**Function**	**Operation**
View	Label		Label the X- and Y-axis as well as the individual cross-sectional pictures	Click button - in the window which opens the axes and the curves can be labelled
	Grid		Display / hide grid net	Click button - if the button is enabled the cross-sectional pictures will be shown with grid, if the button is disabled the cross-sectional pictures will be shown without grid
	Data table		Display the value table for the current cross-sectional picture	Click button or icon - the value table for the current cross-sectional picture will be indicated
	Histogram of height frequencies		Display of frequency distribution of height values in the cross-sectional picture	Click button - a histogram window of the frequency distribution of height values of the cross-sectional picture

				opens
	Set y-limits		Set minimum and maximum value of Y axis	Click button - in the window which opens the minimum and maximum value of Y axis can be set
	Erase Y limits		Erase set minimum and maximum value of the Y axis = return to automatic maximum scaling of Y axis	Click button - set minimum and maximum value of Y axis is erased and the curve will be shown with automatic maximum scaling of Y axis

Menu	**Button**	**Icon**	**Function**	**Operation**
View	Enter X limits		Set minimum and maximum value of X axis	Click button - in the window which opens the minimum and maximum value of X axis can be set
	Chancel X-limits		Erase set minimum and maximum value of the X axis = return to automatic maximum scaling of X axis	Click button - set minimum and maximum value of X axis is erased and the curve will be shown with automatic maximum scaling of X axis
	Change shifting value in mm		Determine the step width for the profile line in the cross section using the up / down / left / right buttons	Click button – A window for the Step size of the shifting in X and Y direction opens
Geometry	Horizontal distance		Determine distance of two points in X-direction selected previously by mouse click (horizontal	Mark two points on the curve; click button – the distance of the two points in X-direction (horizontal distance) will be indicated

			distance)	
	Vertical distance		Determine distance of two points in Y-direction selected previously by mouse click (vertical distance)	Mark two points on the curve; click button – the distance of the two points in Y-direction (vertical distance) will be indicated
	Distance		Determine real distance of two points selected previously by mouse click	Mark two points on the curve; click button – the distance of the two points in Y-direction (vertical distance) will be indicated
	Curve length		Determine stretched length of cross-sectional curve between two points selected previously by mouse click	Mark two points on the curve; click button – the stretched length of cross-sectional curve between the two points will be indicated

Menu	**Button**	**Icon**	**Function**	**Operation**
Geometry	Angle (acute)		Determines the acute angle between two straight line segments or a straight line segment and the X axis or reference line	Mark two points on the curve; click button – the angle between straight-line defined by the two points and the X-axis will be indicated; Mark 3 points on the curve; click button – the angle between straight-lines defined by the two pairs (points 1-2 and 2-3) of points will be indicated Mark four points on the curve; click button – the angle between straight-lines defined by the two pairs (points 1-2 and 3-4) of points will be indicated

	Angle (obtuse)		Determines the obtuse angle between two straight line segments or a straight line segment and the X axis or reference line	Mark two points on the curve; click button – the angle between straight-line defined by the two points and the X-axis will be indicated; Mark 3 points on the curve; click button – the angle between straight-lines defined by the two pairs (points 1-2 and 2-3) of points will be indicated Mark four points on the curve; click button – the angle between straight-lines defined by the two pairs (points 1-2 and 3-4) of points will be indicated

Menu	**Button**	**Icon**	**Function**	**Operation**
Geometry	Radius		Determines the radius of a curve	Mark two or three points on the curve; click button – the radius will be indicated
	Distance of positive peaks		Determine quantity, average distance, standard deviation, maximal and minimal distances for positive peaks	Click button – the quantity, average distance, standard deviation, maximal and minimal distances for positive peaks will be shown
	Distance of negative peaks		Determine quantity, average distance, standard deviation, maximal and minimal distances for negative peaks	Click button – the quantity, average distance, standard deviation, maximal and minimal distances for negative peaks will be shown

Parameters	Roughness parameters		Determine roughness characteristics for current cross-sectional picture	Click button or icon – the window for calculation of the roughness characteristics of the current cross-sectional picture opens
	Roughness profile		Display roughness profile for current cross-sectional picture	Click button – the roughness profile for current cross-sectional picture will be indicated
	Waviness profile		Display waviness profile for current cross-sectional picture	Click button – the waviness profile for current cross-sectional picture will be indicated
	Material bearing curve		Display material bearing curve (Abbot curve) for current cross-sectional picture	Click button – the material bearing curve for current cross-sectional picture will be indicated

20.5. Menu “Database ”

After running the database program of the PRIMOS software the following functions are available:

Menu	**Button**	**Icon**	**Function**	**Operation**
File	Open database		Opens a saved database (*.bnk-Format)	Click button or icon; select folder, file format and file name; click “Open”
	Insert files		Inserts files into database	Click button or icon – the file selection window opens; select files to be inserted into the database and click “apply”
	Save all in new		Save the measuring files included in the	Click button - the file selection windows opens; select place for

	directory		database in a new directory	creation of a new folder; enter a new folder name at the field “New”; click “OK”; click “Save” – all files will be stored in the new folder
	Save database		Save database	Click button or icon; input file name; select format and folder for storage; click “Save”

Menu	**Button**	**Icon**	**Function**	**Operation**
File	Export all		Export data files of database to another format	Click button - the export selection windows opens; select file format for export; select folder for storage of exported files (if requested select place for creation of a new folder; enter a new folder name at the field “New”; click “OK” right of the field); click “OK” at bottom of the window – files will be stored in the selected folder
	Close		Closes the database window	Click button or icon – the current window will be closed
Component	Mark single entry		Mark a single height pictures in the database	Click button or icon to enable or disable single marking function – if function is enabled single height pictures can be marked by positioning of cursor on the appropriate height picture and clicking after left mouse button
	Mark all entries		Mark all height images	Click button – all height

			in the database	pictures of database are marked
	Mark no entry		No entry in the database is marked	Click button – no height picture of database is marked
	Default file group		Group files for elastic matching	Click button – the grouping of height pictures (before adjusted) will be performed
	Form new file groups		Adjustment of file grouping for elastic matching	Click button – the window for adjustment of file groups opens

Menu	**Button**	**Icon**	**Function**	**Operation**
Components	Switch position between two entries		Swap positions of two height pictures in the database	Click button – enable or disable function for position swap of two height pictures in the database – if enabled click with left mouse button in one height picture, hold the button and move it to the other height picture, release the mouse button – the two height pictures will swap their positions
	Delete entry		Delete a height picture from the database	Click button – enable or disable function for deletion of height picture from database – if enabled click with left mouse button in height picture to be deleted – the height picture will be deleted from the database
	Delete marked entries		Delete marked height pictures from database	Click button – all marked height pictures will be

				deleted from the database
	Delete entry and file		Delete currently selected height picture from database and the appropriate data file from hard disk	Click with left mouse button the height picture to be deleted; click button – the selected height picture will be deleted from the database and the appropriate data file from hard disk
	Delete marked entries and files		Delete marked height pictures from database and the appropriate data files from hard disk	Mark the height pictures to be deleted; click button – the marked height pictures will be deleted from the database and the appropriate data files from the hard disk
	Sort entries by name forward		Sort height pictures of database by name in alphabetical order	Click button – the height pictures of the database will be sorted by name in alphabetical order

Menu	**Button**	**Icon**	**Function**	**Operation**
Component	Sort entries by name backwards		Sort the height pictures in the database by name in reverse alphabetical order	Click button – the height pictures of the database will be sorted by name in reverse alphabetical order
	Sort entries by time forward		Sort the height pictures is the database by time of creation, forwards	Click button – the height pictures in the database are sorted by time of creation, forwards (oldest file on first position)
	Sort entries by time backward		Sort the height pictures in database by time of creation,	Click button – the height pictures in the database are sorted by time of creation, backwards (newest file on first

			backwards	position)
	Open parameters		Insert marking parameters saved in a marking file in all selected height pictures of the database	Click button; select folder and file name of marking file; click “Open” – the markings are inserted in all selected height pictures of the database; to show the inserted markings, click the appropriate indication buttons or icons
	Insert parameters		Insert marking parameters from the clipboard in all selected height pictures of the database	Click button – the markings in the evaluation mode before copied to the clipboard will be inserted in all selected height pictures of the database; to show the inserted markings, click the appropriate indication buttons or icons
Edit	Undo		Undo the last operation of data evaluation	Click button or icon – the operation (filtering, alignment, …) carried out last, will be undone

Menu	**Button**	**Icon**	**Function**	**Operation**
Edit	Draw new		Delete all markings from the height pictures	Click button or icon – all markings will be deleted from the height pictures
	Cut		Cutting out of a marked area in selected height pictures	Click button – the marked area(s) of the height images are cut out
	Trim		Cutting out the area around a marking in the selected height images	Click button – Areas around markings in height images are cut out

	Inverse picture		Inverts the selected height pictures (calculation of the height picture print)	Click button - the height images are inverted
	Flip vertical		Mirrors the selected height pictures vertically	Click button – the height pictures are mirrored vertically
	Flip horizontal		Mirrors the selected height pictures horizontally	Click button – the height pictures are mirrored horizontally
	90° left		Rotate the selected height pictures 90° left	Click button – the height pictures are rotated 90° left
	90° right		Rotate the selected height pictures 90° right	Click button – the height pictures are rotated 90° right
	180° Turn		Rotate the selected height pictures 180°	Click button – the height pictures are rotated 180°

Menü	**Schaltfläche**	**Symbol**	**Funktion**	**Bedienung**
Edit	Turn		Rotate the selected height pictures a freely selectable angle	Click button; select angle and direction of rotation; click “OK” – the height pictures are rotated corresponding to the selected angle and direction of rotation
	New scaling		Change the scaling of the selected height pictures	Click button; select the scaling factors (x, y , z) and the height offset (z) for re-scaling of the height picture; click “OK” – the height pictures are re-scaled corresponding to the entered scaling factors (x, y , z) and

				the height offset (z)
	New resolution		Change the height resolution of the selected height pictures	Click button; select value and measure of the new height resolution; click “OK” – the height resolution of the height pictures will be changed corresponding to the entered value
Operation	Align		Justify the selected height pictures to averaged plane or to marked areas of the height picture	Click button – reorientation of the height pictures to average plane or a plane defined by previously marked areas
	Polynomial filter		Removes the deviation from a geometric form of selected height pictures corresponding to the selected class of polynomial	Click button; in the window which opens, select the rank of polynomial; click “Evaluate”; click “Difference” - the height pictures after removal of geometric form are shown
	Robust high pass filter		Separates the fine structure of the skin	Click button – the height pictures are displayed after the separation of the fine structure of the skin

Menu	**Button**	**Icon**	**Function**	**Operation**
Operation	Remove invalid		Assigning of adjacent height value in case of absence of own height value for the measuring point (for previously selected	Click button – measuring points with missing height values are assigned height values of adjacent measuring points

			height pictures)	
	Remove hairs		Elimination of hairs from the measuring data of skin surface (for previously selected height pictures)	Click button – Hairs are removed from the selected height images
	Gaussian filter		Applies a Gaussian filter to previously selected height pictures	Click button; In the window which opens, select direction and size of filtering; click “OK“– The height pictures are displayed after use of the Gaussian filter
	Median filter		Applies a median filter to previously selected height pictures	Click button; in the window which opens, select the area, the direction and the size of filter application; click “OK” – the height picture after application of median filter is shown
	Average filter		Applies an average filter to previously selected height pictures	Click button; in the window which opens, select the area, the direction and the size of filter application; click “OK” – the height picture after application of the average filter is shown

Menu	**Button**	**Icon**	**Function**	**Operation**
Evaluate	Surface size		Determine the “stretched” area of a surface or parts of a surface, previously marked in the	Click button; the results indicated below the selected height pictures are the “stretched” area of the height images or its previously

			selected height pictures	marked part
	Lump analysis		Determination of position, dimensions, area and height of lumps and similar structures on skin for selected height pictures	Click button – for structures like nevus, lumps, … of selected height pictures, the position, volume, area and maximum height are determined; the appropriate parameters can be saved using the button “Evaluate/ Save lump parameter” or indicated using the button “View/ Lump parameter”
	Volume on upper reference plane		Determines the volume of a height profile (or a part of it) below a reference plane for previously selected height pictures	Click button – below the selected height pictures, the volume of the height profile (or a part of it) below the reference plane will be indicated
	Volume on lower reference plane		Determine volume of height profile(or a part of it) above a reference plane for previously selected height pictures	Click button – below the selected height pictures the volume of the height profile (or a part of it) above a reference plane will be indicated

Menu	**Button**	**Icon**	**Function**	**Operation**
Evaluate	Volume of balanced plane		Determine volume of height profile (or a part of it) below and above a reference plane for before selected height	Click button – below the selected height pictures, the volume of height profile (or a part of it) below and above a reference plane will

			pictures	be indicated
Group evaluation	Define line roughness		Determine line roughness parameters for selected height pictures	Insert an intersecting line in the selected height pictures; click button; set parameters for roughness determination; click “Group evaluation/Start evaluation” – the line roughness for cut lines in selected height pictures will be determined; the roughness parameters can be stored automatically (if enabled) in an ASCII file and displayed by clicking the button “View/ Line roughness” or the icon
	Define surface roughness		Determines the area roughness parameters for selected height pictures	Click button; set parameters for roughness determination; click “Group evaluation/Start evaluation” – the area roughness for selected height pictures will be determined; the roughness parameters can be stored automatically (if enabled) in an ASCII file and displayed by clicking the button “View/ Surface roughness” or the icon

Menu	**Button**	**Icon**	**Function**	**Operation**
Group evaluation	Define star roughness		Determines the star roughness parameters for selected height	Click button; set parameters for roughness determination; click “Group evaluation/Start

			pictures	evaluation" – the star roughness for selected height pictures will be determined; the roughness parameters can be stored automatically (if enabled) in an ASCII file and indicated by clicking the button "View/ Star roughness" or the icon
	Start evaluation		Start calculation of roughness parameters for previously selected height pictures and type of roughness	Click button – the roughness parameters will be calculated for previously selected height pictures and type of roughness
	Stop evaluation		Stop calculation of roughness parameters for previously selected height pictures and type of roughness	Click button – the calculation of roughness parameters for previously selected height pictures and type of roughness is stopped
	Start elastic matching with filling		Perform elastic matching for previously grouped files with filling of gaps in matched height pictures with data from the reference height picture	See chapter "Database"
	Start elastic matching without filling		Perform elastic matching for previously grouped files without the filling	See chapter "Database"

			of gaps in matched height pictures with data of reference height picture	

Menu	Button	Icon	Function	Operation
View	Line roughness		Show results of previously carried out line roughness calculation	After the line roughness calculation, click the button or icon – the table of determined roughness parameters is displayed
	Surface roughness		Show results of previously carried out surface roughness calculation	After the surface roughness calculation, click the button or icon – the table of determined roughness parameters is indicated
	Star roughness		Show results of previously carried out Star roughness calculation	After the star roughness calculation, select the height picture for which the roughness parameters should be indicated; click button or icon – the table of determined roughness parameters is indicated
	Lump parameter		Show results previously carried out lump parameter determination	After the lump parameter determination, select the height picture for which the lump parameters should be indicated; click button – the table of determined lump parameters is indicated
	Measurement data		Show results of surface size or volume calculation	After surface size or volume calculation, click button – the table of determined surface

			before for selected height pictures carried out	size or volume values will be indicated; the displayed results can be stored in an ASCII file
	Lines		Display line markings drawn in height pictures	Click button or icon – if enabled, line markings drawn in height pictures are displayed

Menu	**Button**	**Icon**	**Function**	**Operation**
View	Circle		Display circle markings drawn in height pictures	Click button or icon – if enabled, circle markings drawn in height pictures are displayed
	Ellipse		Display ellipse markings drawn in height pictures	Click button or icon – if enabled, ellipse markings drawn in height pictures are displayed
	Rechtecke		Display rectangle markings drawn in height pictures	Click button or icon – if enabled, rectangle markings drawn in height pictures are displayed
	Polygon line		Display polygon line markings drawn in height pictures	Click button or icon – if enabled, polygon line markings drawn in height pictures are displayed
	Freehand line		Display freehand line markings drawn in height pictures	Click button or icon – if enabled, freehand line markings drawn in height pictures are displayed
	Display cross section		Displays the cross section of any markings drawn into the height image	Click button or icon – The cross section of the markings drawn into the height image is displayed
	Thumbnails		Setting the displays size of the overview	Click button and select the size of the overview pictures in the

			pictures	sub menu

Menu	Button	Icon	Function	Operation
			Open the currently selected height picture in the 3D representation window	Click icon – the currently selected height picture will be opened in the 3D representation window for further processing
			Set colour scale for height picture	Click button or icon – the window for the selection of the colour scale of the height picture opens
Macro	Macro…		Start a macro for data processing	Mark height pictures to be processed; click button; click macro requested for data processing – the data processing steps of the macro will be applied to all selected height pictures
	Macro-Info.		Information about the available macros	Click button - a window containing information regarding the available macros is displayed
Info			File information of the marked height picture	Click button – the file information for the marked height picture will be indicated
Settings	Matching procedure		Setting of parameters for the 3D matching	Click button – a window for the setting of parameters for the 3D matching in opened

20.6. Menu “Open print folder ”

After running the print folder program the following functions are available:

Menu	Button	Icon	Function	Operation
File	New		Create a new page / print document	Click button or icon – a new document page will be created (all objects will be deleted from existing page)
	Open		Open a stored print file (*.prt)	Click button; select folder and file name; click “Open”
	Save		Store the print document as print file (*.prt)	Click button or icon; input file name ; select folder for storage; click “Save”
	Close		Schließen des Dokumentendruckfensters	Schaltfläche oder Symbol anklicken – das aktuelle Fenster wird geschlossen
Edit	Create new text field		Create a text field in the document	Click button or icon; position the cursor in the document at the place where the text field should be inserted; click left mouse button – a text field will be inserted

Menu	Button	Icon	Function	Operation
Edit	Insert graphic		Insert a graphic from the clipboard into the document	Click button or icon; position the cursor in the document at the place where the graphic should be inserted; click the left mouse button – a graphic is inserted
	Insert text		Insert text from other documents	Function not yet available
	Paragraph left justified		Justify paragraph left	Position the cursor in the text to be justified; click the left mouse button; click button or icon – the text will be justified left
	Paragraph right justified		Justify paragraph left	Position the cursor in the text to be justified; click the left mouse button; click button or icon – the text will be justified right
	Paragraph centred		Centre text	Position the cursor in the text to be justified; click the left mouse button; click button or icon – the text will be centred
	Select font		Set text font for document design and printing of the document	Click on button or icon – the window for selection of the text font opens
	Background colour for text		Set background colour for text	Click on button or icon – the window for selection of the background colour of the text opens

Menu	Button	Icon	Function	Operation
Edit	Bring object to front		Position an object in front of a second object	Mark the object to be positioned in front of a second object by clicking the left mouse button; click on button or icon – the marked object will be positioned in front
	Delete object		Delete an object from the document	Position the cursor on the object to be deleted; click left mouse button; click button or icon – the object will be deleted
View	Portrait landscape	 	Set the format of the document - portrait or landscape	Click button or icon – the document format will be (= portrait enabled; = landscape enabled)
	Page preview / Edit mode		Change between page preview and edit mode (edit mode = above described functions)	Click button or icon – the document mode changes from edit mode to page preview or back; in the page preview mode the magnification of the document can be selected or the document can be printed
	25, 50, 75, 100, 150, 200, 400 %		Select magnification of the document in the page preview mode	Click button or icon for the requested magnification – the document will be shown in the selected magnification
	Print		Print document	Click button or icon – the document will be printed

20.7. Menu “3D-Matching for elastic surface structures ”

After running the 3D matching program of the PRIMOS software the following functions are available in the 3D matching window:

Menu	Button	Icon	Function	Operation
File	Reload measurement data		Undo the 3D matching	Click button – the 3D matching will be undone
	Open reference …		Open a stored 3D measuring file (*.fd3, *.omc, *.sdf) as reference for 3D matching	Click button or icon; select folder, file format and file name; click “Open”
	Open measurement data...		Open a stored 3D measuring file (*.fd3, *.omc, *.sdf) as measuring data for 3D matching	Click button or icon; select folder, file format and file name; click “Open”
	Save measurement data as …		Store the matched height picture of measuring data	Click button; input file name; select format and folder for storage; click “Save”
	Save reference structure as…		Store the structure height picture of reference data	Click button; input file name; select format and folder for storage; click “Save”
	Save reference course as …		Store the course height picture of reference data	Click button; input file name; select format and folder for storage; click “Save”
	Save measurement data Structure as…		Store the structure height picture of measuring data	Click button; input file name; select format and folder for storage; click “Save”

Menu	Button	Icon	Function	Operation
File	Save measurement data Course as...		Store the course height picture of measuring data	Click button; input file name; select format and folder for storage; click “Save”
	Copy image to clipboard		Copy the current image to clipboard	Click button or icon - the current presentation is copied to the clipboard
	Close		Close the 3D matching window	Click button or icon – the current window is closed
Edit	Start matching		Performs the matching of reference and measuring data	Click button or icon – the 3D matching of reference and measuring data are performed
	Remove hairs from reference		Applies a hair filter to the reference data	Click button – hairs are removed from the reference height picture
	Remove hairs from measurement data		Apply a hair filter to the measuring data	Click button – hairs will be removed from the measuring height picture
	Fill gaps with reference data		Fill in missing data in the matched high picture with reference data	Click button – gaps existing in the measuring height picture after matching (no height data) will be filled with the corresponding data from the reference height picture
	Draw lines		Mark a line in a height picture	Click button or icon; position the cursor in a height picture at the starting point of the line to be drawn; click the left mouse button; hold it and move the cursor to the end point of the line to be drawn; release the left

				mouse button – the line is drawn in all height pictures

Menu	Button	Icon	Funtion	Operation
Edit	Structure lines filter		Create an average cut line of a selectable number of cut lines located close and parallel to the cut line drawn in the height picture	Click button; click the requested number of parallel lines – the cut line shown in the cut line diagram will be the average of the draw cut line and the selected number of close located parallel cut lines
View	Split windows		Show height pictures of reference and measuring data in one window	Click button or icon – height pictures of reference and measuring data will be shown in one window if enabled
	Reference		Show reference data height picture	Click button or icon – if enabled the height picture of reference data will be shown
	Measurement data		Show measuring data height picture	Click button or icon – if enabled will be shown the height picture of measuring data
	Difference		Show difference height picture of reference and measuring data	Click button or icon – if enabled will be shown the difference height picture of reference and measuring data
	Structure height picture		Show structure height picture	Click button or icon – if enabled will be shown the structure height picture
	Course height picture		Show course height picture	Click button or icon – if enabled will be shown the course height picture

Menu	Button	Icon	Function	Operation
View	Original height picture		Show entire height picture	Click button or icon – if enabled will be shown the entire height picture
	Show cut line diagram		Display a cross-sectional picture (2D profile) for the cut line marked before in the height picture	Click button or icon – the window for presentation of 2D profiles (cross-sectional pictures) for lines marked before in the height picture opens
	Lateral deformation		Show lateral deformation of matched height picture	Click button or icon – the lateral deformation of matched height picture will be shown
	Height deformation		Show vertical deformation of matched height picture	Click button or icon – the vertical deformation of the matched height picture will be shown
	Set colour palette		Set the colour scale for the height picture	Click button or icon – the window for selection of colour scale of height picture opens

Menu	Button	Icon	Function	Operation
			Enable the zoom function for the height pictures	Click icon; position the cursor at one edge of the height image area to be zoomed; click the left mouse button; hold it and move the cursor to the diametrically opposed edge of the height image area to be zoomed; release the left mouse button – the appropriate area of the height image will be shown zoomed For zoom reset position the cursor anywhere in the height image and click the right mouse button
Settings	Matching procedure		Opens the window for setting the matching parameters	Click button – the window for the setting of the matching parameters is opened

The above named functions are described further in separate chapters of the user manual.

Instruction for setup and use of LMI optical 3D sensors

The following instruction applies to setup and use of LMI optical 3D sensors with computers running under the operating systems Microsoft Windows XP or Windows 7. The connection of sensor and computer is realized via network (Ethernet).

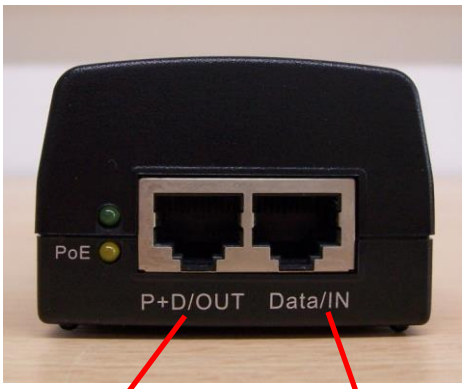
I. Hardware installation

The hardware of measuring system consists of the following components:

- Optical 3D sensor
- PoE power supply for sensor
- Two network cables
- Power cable for PoE power supply
- Computer with operating system Microsoft Windows XP or Windows 7

For installation of measuring system connect sensor, PoE power supply and computer by means of the two network cables as follows:

1. Use the shorter network cable to connect the **computer** (Ethernet port) with the port **Data/IN** of PoE
2. Use the longer network cable to connect the **sensor** (Ethernet port) with the port **P+D/OUT** of PoE
3. Connect the power cable to PoE only (but not to power line at this moment!)



Optical 3D sensor

Computer

II. Software installation

The following instruction applies to the installation of a working copy (program folder) of measuring software (**ODSCAD** or **PRIMOS**) on the measuring computer. The installation of installation versions of measuring software is described in the corresponding software or, respectively, measuring system manuals.

Install the copy of measuring software or, respectively, program folder (**ODSCAD** or **PRIMOS**) as follows:

1. Run the measuring computer.
2. Open the Windows Explorer on your computer and move to hard disk **C** (C:\).
3. Create on the hard disk, i.e. directly under C:\ a folder **LMI**.
4. Insert the medium with the measuring software (CD, USB stick, etc.) in your computer.
5. Copy the folder **ODSCAD** … or, respectively, **PRIMOS** … from the medium into the above mentioned folder **LMI**.
6. Move inside the folder **ODSCAD** … or, respectively, **PRIMOS** … and create a shortcut for the program file **ODSCAD.exe** or, respectively, **Primos.exe** on the desktop. Name the shortcut appropriate.
7. Remove the medium from the computer and close the Windows Explorer.

III. Startup of sensor

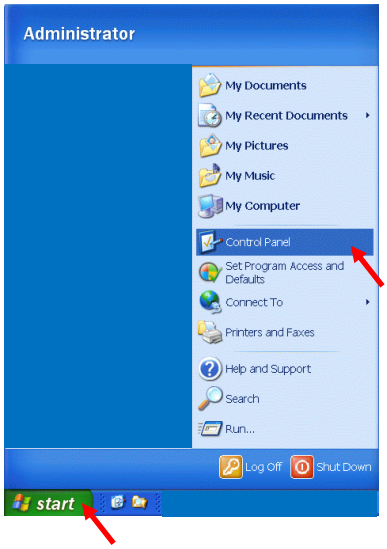
For startup of sensor act as follows:

1. Connect the power supply of sensor (PoE) with the power line.
2. After some seconds the green LED on the sensor starts periodically to blink. The computer in the sensor is booting. Wait until the green LED on the sensor stops periodically to blink and is permanent illuminated. The sensor then has finished the boot process and is ready for connection with the computer via network.

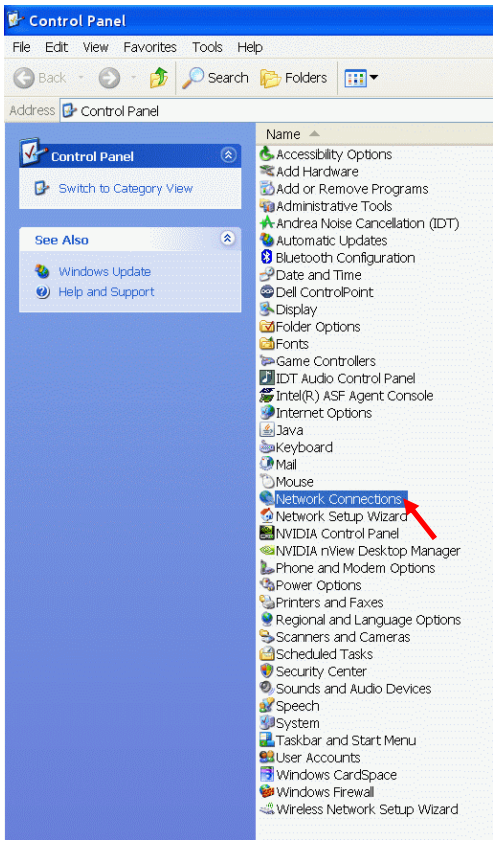
IV. Configuration of network connection for Windows XP and Windows 7

A) Configuration of network connection for Windows XP

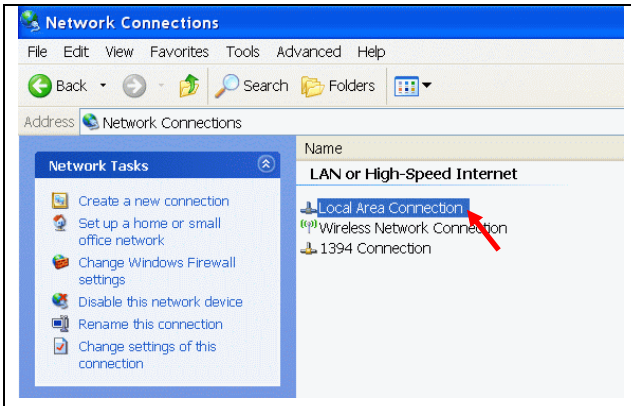
For configuration of network connection act as follows:



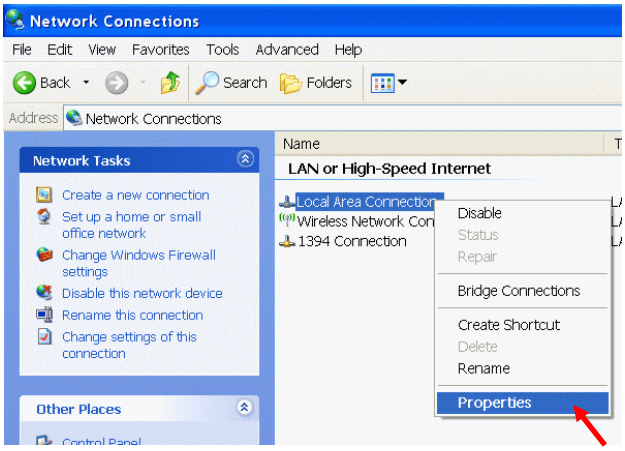
Click with left mouse **Start** and following **Control Panel**.



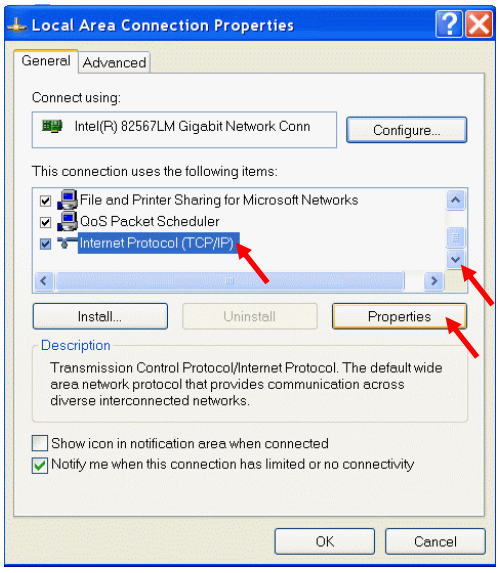
Double click with left mouse **Network Connections**.



Move mouse on **Local Area Connection** and click right mouse.



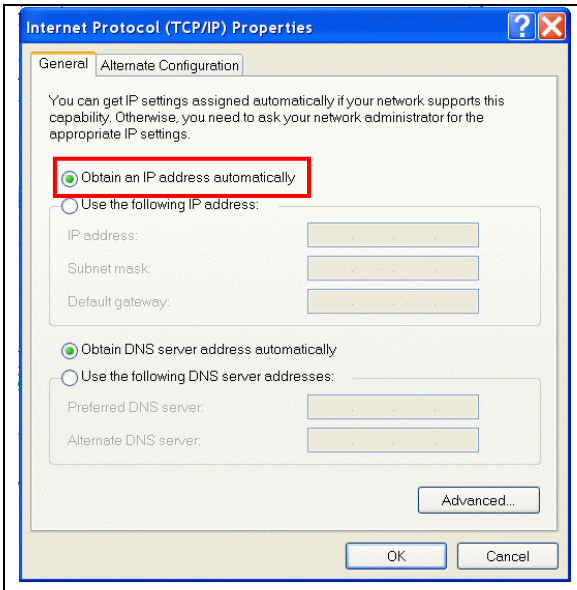
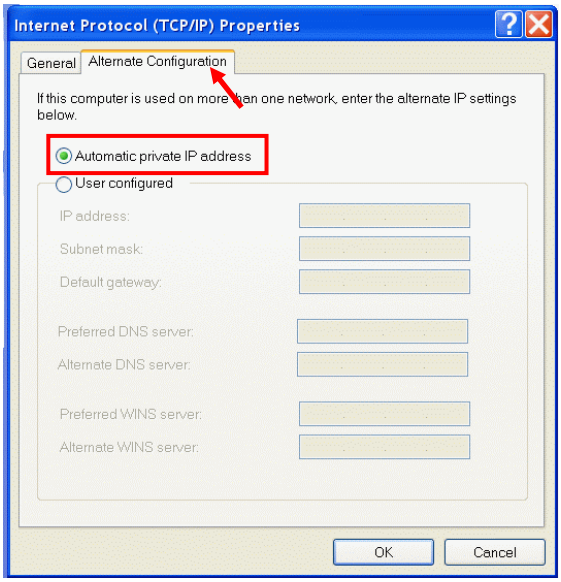
Click with left mouse **Properties**.


Local Area Connection Properties
General Advanced
Connect using:
Intel(R) 82567LM Gigabit Network Conn
Configure...
This connection uses the following items:
File and Printer Sharing for Microsoft Networks
QoS Packet Scheduler
Internet Protocol (TCP/IP)
Install...
Uninstall
Properties
Description
Transmission Control Protocol/Internet Protocol. The default wide area network protocol that provides communication across diverse interconnected networks.
Show icon in notification area when connected
Notify me when this connection has limited or no connectivity
OK
Cancel

Scroll the field **This connection uses the following items:** down.

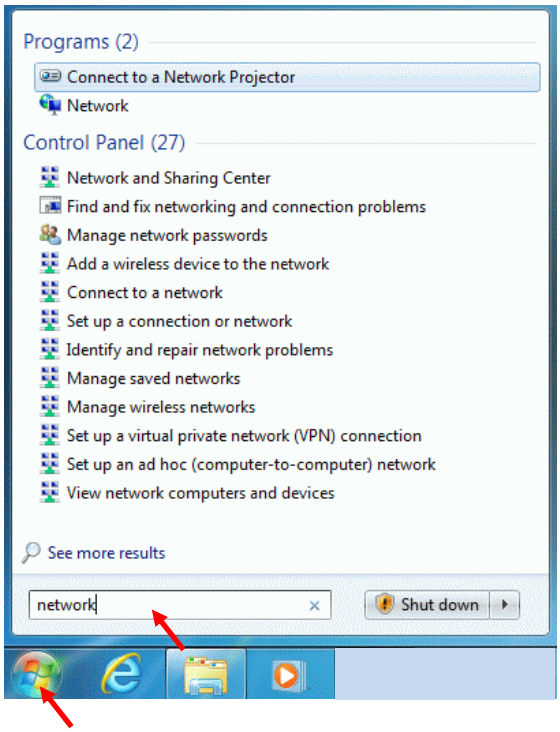
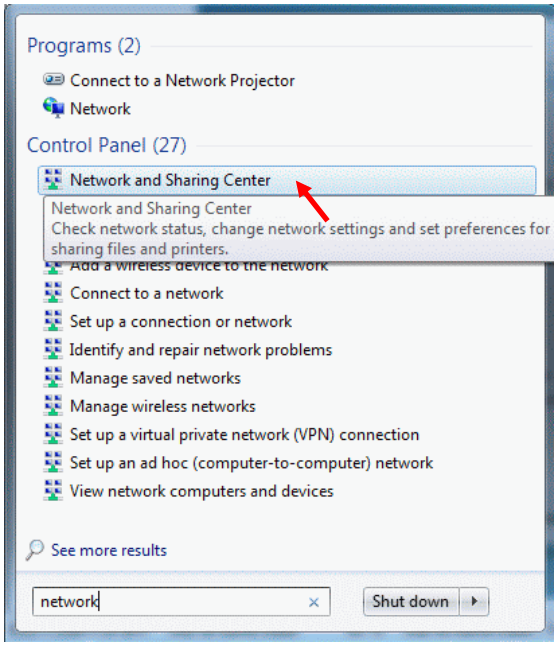
Click with left mouse **Internet Protocol (TCP/IP)**.

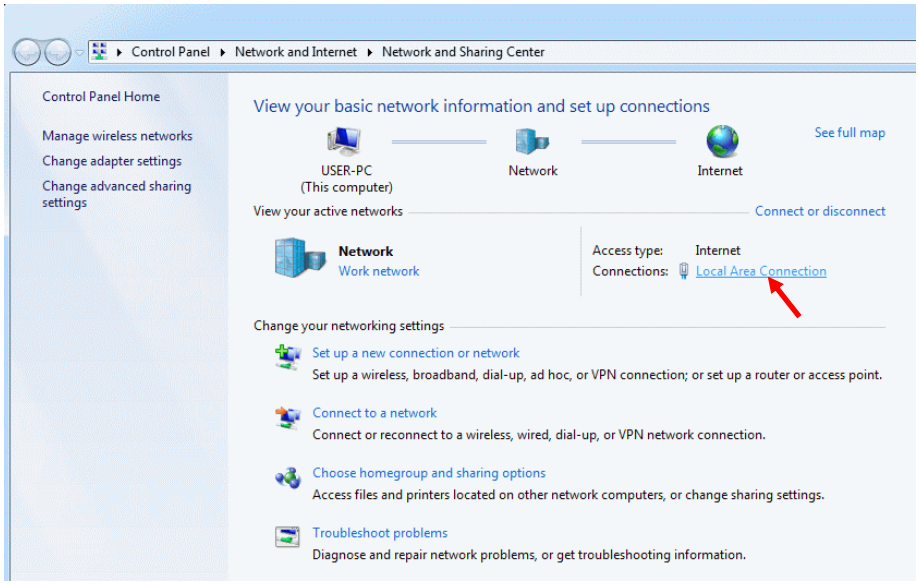
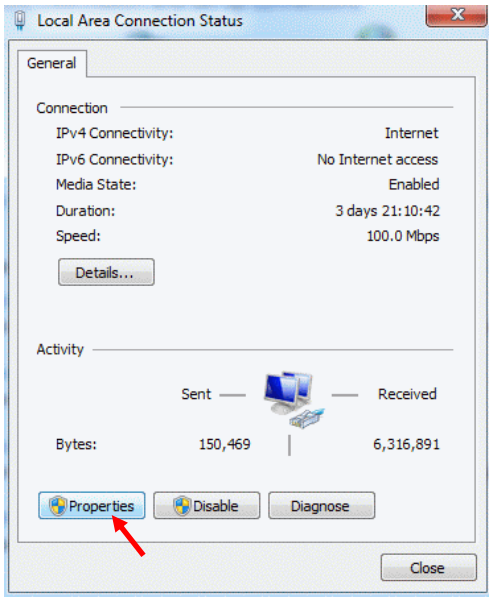
Click with left mouse **Properties**.

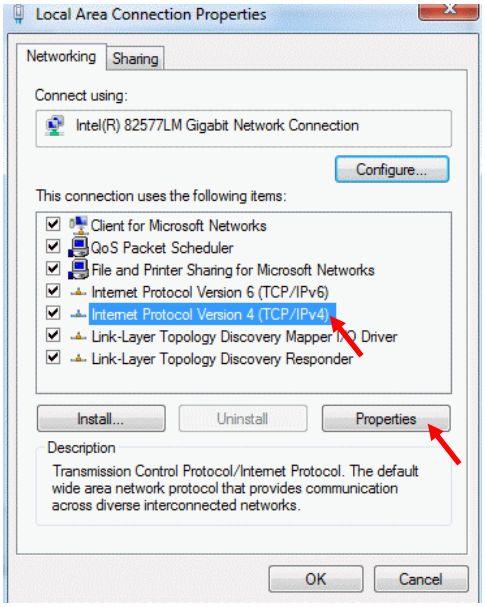
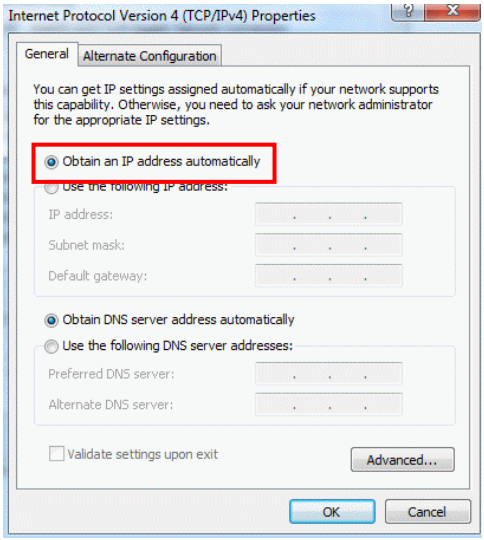
	The correct setting in the window **General** is **Obtain an IP address automatically**. If necessary, change the setting.
	Click with left mouse **Alternate Configuration**. The correct setting in the window **Alternate Configuration** is **Automatic private IP address**. If necessary, change the setting. After all settings are correct adjusted, click with left mouse **OK**, **Close** and close the window **Network Connections**.

B) Configuration of network connection for Windows 7

For configuration of network connection act as follows:

	Click with left mouse **Start** and following input **network** in the search box.
	Click with left mouse **Network and Sharing Center**.

	Click with left mouse **Local Area Connection**.
	Click with left mouse **Properties**.

	Click with left mouse **Internet Protocol Version 4 (TCP/IPv4)** in the field **This connection uses the following items:**. Click with left mouse **Properties**.
	The correct setting in the window **General** is **Obtain an IP address automatically**. If necessary, change the setting.

V. Use of measuring system after setup

For daily use of measuring device act as follows:

1. Run the measuring computer.
2. Connect the power supply of sensor (PoE) with the power line. After some seconds the green LED on the sensor starts periodically to blink. The computer in the sensor is booting. Wait until the green LED on the sensor stops periodically to blink and is permanent illuminated. The sensor then has finished the boot process and is ready for connection with the computer via network.
3. Double click the icon of the measuring software (ODSCAD or PRIMOS) on the desktop. The start window of measuring software opens. Following operate and use measuring device and measuring software as described in the manual for the measuring system.

   Remark: If opening the measuring window when the network connection between computer and sensor is not yet established the measuring window closes after some seconds. Wait some more seconds and open the measuring window again.
4. Disconnect the power supply of sensor (PoE) from power line if the computer is used for data evaluation only.
5. After use of measuring system for system shutdown disconnect the power supply of sensor (PoE) from power line and shut the measuring computer down.

Remark: If the firewall at first start of measuring software after its installation is asking for permission grant it.